2006 Building Code Technical Training Courses

Resource Conservation House – 2006

Participant's Manual

Building and Development Branch
Ministry of Municipal Affairs & Housing

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2006 Building Code
Technical Training Courses

Resource Conservation House - 2006

PARTICIPANT'S MANUAL

This course was developed by **Morrison Hershfield Limited**

for the **Ontario Ministry of Municipal Affairs and Housing.**

The course is based on the Ontario Building Code 2006 (O. Reg. 350/06), as amended.

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INTRODUCTION

RESOURCE CONSERVATION HOUSE – 2006

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INTRODUCTION

Welcome! Over the next two days, you will be concentrating on the requirements of resource conservation set out in Part 12 of the 2006 Building Code.

The course has been designed to give you an understanding of the Code requirements applicable to resource conservation for houses designed under Part 9 under the Building Code.

Every effort has been made to cover as much of the Part 12 content as possible. However, participants should consult Division B, Part 12 of the Code to become familiar with all subject matter.

RESOURCES

There are many resources that will assist you in this course, including:

- Your experience as a plan examiner, inspector, or designer
- The experience of others in the class
- The 2006 Building Code and Building Code Act
- Exercises that ask you to understand why the regulations exist and to relate your experience to the information presented
- This workbook. This is your book, and you are encouraged to record answers and write notes in it. It should be a useful reference when you are back on the job.

The resources you will require for the class are this workbook and a 2006 Building Code (Volumes 1 and 2).

These documents are available from:
www.publications.serviceontario.ca

The following resource materials are optional and may be of use in your regular work:

- NRCan "EnerGuide for New Houses: Administrative and Technical Procedures"

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A calculator, a highlighter and some sticky notes may help you mark key tables and requirements.

MEET YOUR GROUP

Before you start into the course materials, it is important for you to meet the people you will be working with during this course. You have had a variety of experiences as a Building Code practitioner, which you can share with the class; similarly, they have had experiences that they can share with you.

EXERCISE 1

Take a few minutes and introduce yourself to your group. Let them known where you're from, and your background. Listen carefully to the types of job experiences that other members of your group have had. They will be useful in completing exercises later on in this course.

Name	Employer and Job Title	Responsibilities

STOP

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THE MUNICIPALITY/REGION

Building plan examinations and inspections take place in the context of the municipality or the region. The types of services offered by the municipality or region have an impact on your role as a building plan examiner or inspector.

EXERCISE 2

Who, in your group, wears more than one hat (or role), and what are they? These people bring a different perspective to a building inspection problem.

Name **"Hats"**

_____

_____

_____

_____

_____

_____

_____

_____

STOP

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ROLES OF THE PLANS EXAMINER, BUILDING INSPECTOR, AND DESIGNER

As Regardless of the other hats you may wear, you have a very important job as a plans examiner and building inspector. Your role is to ensure the health and safety of residents in your community by:

- Providing information - technical knowledge and information about the appropriate legislation - to contractors, the public and your Council.
- Examining the building under your jurisdiction to ensure they comply with regulations.
- Applying, interpreting, administering and enforcing the requirements.
- Employing all your technical and personal skills to gain voluntary compliance with the Code.
- Co-operating with other building officials in the interests of the public.

Being a plans examiner or inspector calls for a combination of technical knowledge and an ability to deal with the public. Technical problems can usually be dealt with fairly easily; but dealing with the public requires tack and good judgement.

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YOUR EXPECTATIONS FOR THIS COURSE

EXERCISE 3

Consulting the course Table of Contents, consider what do you expect to learn from this course?

In your group, discuss this question and write your objectives on your group flip chart. After your group discussion, you'll be sharing these objectives with the rest of the class.

At the end of the course, you will assess how well these expectations have been achieved - so make sure you write them down.

STOP

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FORMAL COURSE OBJECTIVES

This course has some specific objectives in mind. See how closely they match your own.

Upon completion of this course, you will be able to:

- Find Code requirements that govern resource conservation
- Identify different compliance options for energy efficient design for Part 9 residential buildings and houses
- Recognize the transition dates for energy efficient designs
- Identify additional requirements that are not dependant on the submission date of the building permit application
- Recognize when Part 9 requirements are still applicable

COURSE FORMAT

Before you go on to accomplish these objectives, spend a few minutes acquainting yourself with the format of this course.

The course consists of 9 modules, ranging in length from 15 minutes to a few hours.

Each module deals with a particular topic and builds on information presented in previous modules. This logical sequence makes it easier to remember what you've learned, as you progress.

Each module outlines the learning objectives of the module, and has examples and exercises such that you can see how well you are doing.

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You have already encountered one type of exercise that will occur frequently throughout the course - the group discussion. This is probably the most valuable part of the course, as you share your knowledge and experience with your group and learn from them.

A variety of materials will be used to help you learn, such as overheads, diagrams and individual or group exercises.

THE FACILITATOR

An important person in this course is your facilitator. The facilitator is not here to lecture, but to guide your discussions, provide examples from experience, and mediate discussions.

Your facilitator is experienced in resource conservation and can offer valuable hints from years of experience. Don't expect the facilitator to have all the answers - no one does - but he or she can provide guidance for your search for the answers.

STOP

THE OBJECTIVE-BASED CODE FORMAT

The 2006 Building Code is published in an "Objective-Based" format. The Objective-Based format adds to the technical requirements by identifying the underlying objectives and sub-objectives of those requirements. Each technical requirement that is an acceptable solution in Division B is linked to one or more objectives, as well as functional statements.

The Objective-Based format is intended to assist Code users in understanding technical requirements, why they exist and what they are intended to achieve. The Objective-Based Code establishes a framework for evaluating "alternative solutions" against the performance achieved by "acceptable solutions" set out in the Code.

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This course is prepared to discuss the Part 12 Resource Conservation provisions in the 2006 Building Code. Training related to the Objective-Based format, and how to deal with alternative solutions is not part of this course.

A few key points about the Objective-Based Code are below.

The organization of the 2006 Code is:

Division A **Compliance, Objectives and Functional Statements**

The new objectives and functional statements are in Division A. Definitions and the application of the Parts of the Code are here.

Division B **Acceptable Solutions**

This is where the technical requirements of the 2006 Code are located.

Division C **Administrative Provisions**

This Division deals with permits, inspections and qualifications.

Remember that the full reference for Part 12 Resource Conservation is "Division B, Part 12 Resource Conservation". Always specify the appropriate Division if there is any chance of confusion. Where the Division is not referenced within this course, it is Division B.

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A GUIDE TO THE USE OF THE BUILDING CODE

The decimal numbering system of the previous Code is maintained within Divisions A, B and C of the 2006 Code.

The first number indicates the Part of the Division, the second, the Section in the Part, the third, the Subsection and the fourth, the Article in the Subsection. An Article may be further broken down into Sentences (indicated by numbers in brackets), and the Sentence further divided into Clauses, Subclauses, Sub-subclauses, and Paragraphs.

These are illustrated as follows:

12	Part
12.3.	Section
12.3.4.	Subsection
12.3.4.5.	Article
12.3.4.5.(5)	Sentence
12.3.4.5.(5)(a)	Clause
12.3.4.5.(5)(a)(i)	Subclause
12.3.4.5.(5)(a)(i)(A)	Sub-subclause
12.3.4.5.(6).1	Paragraph

Defined Words, Terms and Phrases

Words, terms and phrases with special meaning are defined in Division A, clause 1.4.1.2.(1)(b) of the Building Code, and are shown within the body of the Code in *italics*. The definition always applies unless the word, term or phrase has a special purpose definition listed elsewhere.

Non-Defined Words, Terms and Phrases

Consult Division A, Sentence 1.4.1.12.(1) of the Building Code. It provides direction for dealing with non-defined terms. Note any questions, comments, or concerns in the space provided.

_____

_____

_____

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Abbreviations and Symbols and Referenced Documents

The Building Code uses abbreviations and symbols throughout. Their meaning is found in Division A, Subsection 1.4.2.

For example, the abbreviation RSI means thermal resistance, International System of Units.

Abbreviations for organizations and associations (proper names) are found in Table 1.3.2.1. in Division B. For example, ASHRAE means American Society of Heating, Refrigerating and Air-Conditioning Engineers.

All documents referenced in the Code are found in Part 1, Division B, Table 1.3.2.1.

BASIC RULES FOR READING THE CODE

Scope and Application of Code Requirements

Individual requirements within the Code do not apply to every *building*. Guidance in the application of each of the 12 Parts of Division B is found in Division A, Subsection 1.1.2.

For this course, it is important to know that Part 12 of Division B applies to all buildings, however not all provisions included in Part 12 apply to Part 9 residential buildings and houses.

Dealing with 'And'

The word '**and**' found at the end of the second last Clause of a Sentence with multiple Clauses means that the requirements of **every** Clause apply to the Sentence.

For example, Division B, Sentence 12.2.1.1.(5) reads:

> *Sentence (1) does not apply to,*
>
> *(a) Farm buildings,* ***and***
>
> (b) *Buildings intended primarily for manufacturing or commercial or industrial processing.*

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Dealing with 'Or'

The word '**or**' found at the end of the second last Clause of a Sentence with multiple Clauses means that the requirement of the Sentence is satisfied by **any** Clause as applied individually.

For example, Division B, Sentence 12.2.1.1.(3) reads:

> *The energy efficiency of a building or part of a building of residential occupancy that is within the scope of Part 9 and is intended for occupancy on a continuing basis during the winter months shall,*
>
> *(a) Conform to the thermal insulation requirements of Subsection 12.3.2.,*
>
> *(b) Conform to the thermal design requirements of Subsection 12.3.3., **or***
>
> *(c) Provide a rating of 80 or more when evaluated in accordance with NRCan "EnerGuide for New Houses: Administrative and Technical Procedures".*

Rules of the Building Code

The Code is structured into a number of Rules that apply without exception.

For example, Division B, Sentence 12.2.2.1.(3) states:

> *A motion sensor shall not be used to control emergency lighting.*

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General Rules of the Building Code and Exceptions

At other times, the user of the Building Code has to consider a general rule and exceptions that may be applicable.

Consider the application of energy efficiency for buildings within the scope of Part 9 given in Division B, Article 12.3.1.1.:

(1) Except as provided in Sentence (2), this Section applies to the energy efficiency of buildings within the scope of Part 9 intended for occupancy on a continuing basis during winter months.

(2) This Section does not apply to,

(a) Farm buildings, and

(b) *Buildings intended primarily for manufacturing or commercial or industrial processing.*

When the Code spells out a general rule and exceptions thereto, conformity with the Code is obtained by complying with EITHER the general rule OR the exception.

Tables, Text and Footnotes

Whenever you are called upon to use a Table in the Code, you have to consider the text associated with the Table **and** the footnotes.

For example, Division B Table 12.3.2.1.

- Forms part of Sentence 12.3.2.1.(4).
- Note (1) to Table 12.3.2.1. tells us to refer to the Supplementary Standard SB-1 (found in Volume 2 of the Building Code) when determining the number of degree-days for individual locations in Ontario.

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Supplementary Standards And Referenced Documents

The Supplementary Standards, published as Volume 2 of the 2006 Building Code Compendium form an integral part of the 2006 Building Code.

Appendices

The Appendices to the 2006 Building Code, published in Volume 2, have been prepared for convenience only. This material contains explanations that do **not** form part of the Building Code and are **not** intended to limit the ways by which compliance with Code requirements can be achieved.

STOP

LIST OF ABBREVIATIONS

The following abbreviations are used in this course:

E_t	Thermal efficiency of the boiler
MNECB	Model National Energy Code for Buildings
ER	Energy rating
HDD	Heating degree-days
low-E	Low emissivity
RSI	Resistance System International, is a metric measure of the thermal resistance (or resistance to heat flow)
R-Value	The imperial measure of thermal resistance
T_{avg}	Average temperature
U-Value	Thermal conductance, is a measurement of the ability of a material to conduct heat

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ANSWER GUIDE

An answer guide is included at the end of this workbook.

During the class please do not look at the answer guide unless instructed by the facilitator.

If you are working on your own, you are encouraged to try each exercise and quiz yourself before turning to look at the answers.

END

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MODULE 1

APPLICATION OF PART 12
RESOURCE CONSERVATION

RESOURCE CONSERVATION HOUSE – 2006

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INTRODUCTION

This module describes the general application of Part 12 Resource Conservation and the underlying objectives for energy efficient design in buildings. Each of the options for different building types are identified and the mandatory dates for transitioning to new provisions are identified.

OBJECTIVES

Upon completion of this module, participants will be able to:

- Recognize the objectives and functional statements applicable to Part 12 Resource Conservation provisions
- Identify the different options for energy efficient design for residential buildings under Part 9
- Identify the transition dates that will apply to changes to Part 12 for energy efficient design

READ TO THE NEXT STOP.

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APPLICATION OF PART 12

Division B, Part 12 applies to all buildings as required by Division A, Sentence 1.1.2.1.(1). In keeping with the general application of the Building Code, Part 12 applies to the design and *construction* of *buildings*. The terms *construction* and *building* are defined in the Building Code Act as follows:

'Construct' means:

> *to do anything in the erection, installation, extension or material alteration or repair of a building and includes the installation of a building unit fabricated or moved from elsewhere and "construction" has a corresponding meaning.*

'Building' means:

> *(a) a structure occupying an area greater than ten square metres consisting of a wall, roof and floor or any of them or a structural system serving the function thereof including all plumbing, works, fixtures and service systems appurtenant thereto*
>
> *(b) a structure occupying an area of ten square metres or less that contains plumbing, including the plumbing appurtenant thereto,*
>
> *(c) plumbing not located in a structure*
>
> *(c.1) a sewage system, or*
>
> (d) *structures designated in the building code;*

Although Part 12 applies to all buildings, there are some "buildings" that will not be affected by the requirements for resource conservation.

COMPLETE THE NEXT EXERCISE

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EXERCISE 1-1

From the definition of "building", identify examples of building types that may not need to be designed in conformance with Part 12 Resource Conservation.

_____

_____

_____

_____

STOP

OBJECTIVES AND FUNCTIONAL STATEMENTS

Table 12 of Supplementary Standard SA-1 "Objectives and Functional Statements Attributed to the Acceptable Solutions" identifies all corresponding linked pairs of functional statement and objectives for each Part 12 provision.

Objectives

Most of the provisions of Part 12 are directly associated with the objective OR2 "Resource Conservation – Energy Conservation" as defined in Division A, Table 2.2.1.1.

> ***OR 2 Resource Conservation – Energy Conservation:*** *An objective of this Code is to limit the probability that, as a result of the design or construction of a building, a natural resource will be exposed to an unacceptable risk of depletion or the capacity of the infrastructure supporting the use of the resource will be exposed to an unacceptable risk of being exceeded, caused by the consumption of energy.*

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However, some of the provisions of Part 12 are associated directly with other objectives including:

- OS3.1 and OS3.7 "Safety – Safety in Use" for motion sensors to control lighting;
- OH1.1 and OH1.2 "Health – Indoor Conditions" for required insulation and air/vapour barrier;
- OS2.3 "Safety – Structural Safety" for required insulation and air/vapour barrier.

OR 1 Resource Conservation – Water Conservation is not directly referenced in Part 12, but is referenced in Subsection 7.6.4, which is referenced by Part 12. OR1 is applicable for the provisions associated with water conservation.

Functional Statements

Most of the provisions of Part 12 are linked to Functional Statement 131 "To limit excessive energy consumption" as listed within Division A, Table 3.2.1.1.

However, other functional statements also apply, including the following:

F10: "To facilitate the movement of persons to a safe place in an emergency" for motion sensors to control lighting

F30: "To minimize the risk of injury to persons as a result of tripping, slipping, falling, contact, drowning or collision" for motion sensors to control lighting

F51: "To maintain appropriate air and surface temperatures" for required insulation

F54: "To limit drafts" for air infiltration limitations

F55: "To resist the transfer of air through environmental separators" for air infiltration limitations

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F63: "To limit moisture condensation" for required insulation

These functional statements are compatible with the provisions of Part 12 Resource Conservation and, with the objectives, identify the areas of performance for Code provisions.

Every requirement under Part 12 has a functional statement/objective linked pair, however, there are some Code provisions where more than one linked pair of objectives/functional statements apply. Each of these linked pairs must be considered if an alternative solution is being considered.

EXAMPLE

What is the functional statement/objective linked pair corresponding to Sentence 12.2.1.1.(3)?

Division B, Sentence 12.2.1.1.(3)

The energy efficiency of a building or part of a building of residential occupancy that is within the scope of Part 9 and is intended for occupancy on a continuing basis during the winter months shall,

(a) conform to the thermal insulation requirements of Subsection 12.3.2.,

(b) conform to the thermal design requirements of Subsection 12.3.3., or

(c) provide a rating of 80 or more when evaluated in accordance with NRCan "EnerGuide for New Houses: Administrative and Technical Procedures.

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Solution:

→ Refer to Table 12 in the Supplementary Standard SB-1

→ In column 1, locate the reference to 'acceptable solution' 12.2.1.1.(3)

→ The corresponding objectives and Functional Statements are identified in column 2

→ One linked pair of objectives and functional statement is linked to Clause 12.2.1.1.(3)(c) F131-OR2

Functional Statement: F131

Objective: OR2

STOP

COMPLETE THE NEXT EXERCISE

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EXERCISE 1-2

For the following Code provisions list the corresponding linked pairs of Objectives and Functional Statements.

Code Provision	Functional Statements and Objectives
Motion Sensors 12.2.2.1.(2)	_____
	_____
Air Infiltration 12.3.3.13.(2)	_____
	_____
	_____
Thermal Resistance 12.3.3.3.(1)	_____
Required Insulation 12.3.2.1.(2)	_____
	_____
	_____
	_____
	_____
	_____

STOP

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SCOPE OF APPLICATION OF PART 12

Part 12 contains requirements for all types of building. The energy efficiency design requirements applicable to Part 9 residential buildings and houses include the following:

- Energy efficient design including
    - Thermal insulation compliance option (Modules 2A and 2B)
    - Thermal design compliance option (Modules 3A, 3B, and 3C)
    - Performance level of NRCan "EnerGuide for New Houses" Compliance Option (Module 4)
- Motion sensors to control lighting (Module 5)
- Water efficiency (Module 6)

As per Division B, Sentences 12.2.1.1.(3) and (5) and 12.2.1.2.(3) and (5), energy efficient design does not apply to farm buildings or buildings primarily for manufacturing or commercial or industrial processing.

ENERGY EFFICIENT DESIGN OPTIONS AND TRANSITION DATES

The provisions for energy efficient design are described for two time periods. For applications for building permit submitted **up to December 31, 2011**, several options are provided for all building types. For applications for building permit **after December 31, 2011**, some of the options are no longer available.

For each of the time periods, the energy efficient design options are different for houses and residential buildings within the scope of Part 9.

STOP

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PART 9 RESIDENTIAL BUILDINGS, UP TO DECEMBER 31, 2011

Houses and other buildings of residential occupancy within the scope of Part 9 can follow any one of the **three possible options** for energy efficient design.

Sentence 12.2.1.1.(3) sets out the minimum requirements relative to energy efficiency for Part 9 residential buildings intended for occupancy on a continuing basis during winter months. Any one of the following provisions can be applied:

Division B, Sentence 12.2.1.1.(3)

(a) ...thermal insulation requirements of Subsection 12.3.2.

(b) ...thermal design requirements of Subsection 12.3.3.

OR

(c) *Provide a rating of 80 or more when evaluated in accordance with NRCan 'EnerGuide for New Houses: Administrative and Technical Procedures'"*

PART 9 RESIDENTIAL BUILDINGS, AFTER DECEMBER 31, 2011

All applications for building permit for Part 9 residential buildings submitted **after December 31, 2011** are required to demonstrate that the building has the performance level that would be achieved by a rating of 80 when evaluated in accordance to NRCan "EnerGuide for New Houses".

After December 31, 2011, the options of complying with the provisions of Division B, Subsection 12.3.2. or 12.3.3. will no longer be available.

The application of the requirements for Subsection 12.3.2. and 12.3.3. are covered in Modules 2A and 2B, and Modules 3A, 3B, and 3C, respectively.

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SUMMARY OF ENERGY EFFICIENCY DESIGN COMPLIANCE OPTIONS

The table below outlines the applicable energy efficiency design compliance options for houses and residential buildings under Part 9.

Summary of Energy Efficiency Design Compliance Options

Energy Efficiency Design Compliance Option Available for Part 9 Residential Buildings	Applicable up to Dec. 31, 2011	Applicable after Dec. 31, 2011	Code Reference
Thermal Insulation (Under Subsection 12.3.2.)	✓	--	12.2.1.1.(3)(a)
Thermal Design (Under Subsection 12.3.3.)	✓	--	12.2.1.1.(3)(b)
NRCan "EnerGuide for New Houses: Administrative and Technical Procedures"	✓	✓	12.2.1.1.(3)(c) and 12.2.1.2.(3)

✓ Applicable
-- Not applicable

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EXAMPLE

A designer wants to design a Part 9 house applying the provisions of Subsection 12.3.2.. What is the last day that the designer has to submit the application for permit?

Solution:

→ Sentence 12.2.1.1.(1) sets out the limitations of applying Subsection 12.3.2. and 12.3.3. as design compliance options for Part 9 residential buildings

The last day the designer can apply for building permit is December 31, 2011 in order to apply the Thermal insulation compliance option (Subsection 12.3.2.).

COMPLETE THE NEXT FOUR EXERCISE

EXERCISE 1-3

Can the provisions for Subsection 12.3.3. be used as a design compliance option for a Part 9 townhouse if the designer submits the application for building permit prior to January 1, 2012?

_____

_____

_____

Code Ref.:_____

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EXERCISE 1-4

A house is being designed, and the building permit application will be submitted in 2009. Which of the following provisions does the designer have to satisfy to meet the minimum energy efficiency requirements?

(a) Provisions of Subsection 12.3.2. "Thermal Insulation for Buildings of Residential Occupancy"

(b) Provisions of Subsection 12.3.3. "Thermal Design for Buildings of Residential Occupancy with the Scope of Part 9"

(c) Performance level of 80 or more when evaluate in accordance with NRCan, "EnerGuide for New Houses: Administrative and Technical Procedures"

(d) Any one of (a), (b), or (c)

_____

_____

_____

_____

_____

Code Ref.:_____

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EXERCISE 1-5

Identify the design provisions that can be used for Part 9 houses if a building permit application is submitted prior to January 1, 2012.

Design Requirements	YES	No	Code Ref.:
Example: Thermal Insulation Compliance Option (under Subsection 12.3.2.)	✓		Clause 12.2.1.1.(3)(a)
Thermal Design Compliance Option (under Subsection 12.3.3.)			
NRCan EnerGuide rating of 80			

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EXERCISE 1-6

Identify the design provisions that can be used for Part 9 houses if a building permit application is submitted after December 31, 2011.

Design Requirements	YES	No	Code Ref.:
Thermal Insulation Compliance Option (under Subsection 12.3.2.)			
Thermal Design Compliance Option (under Subsection 12.3.2.)			
NRCan EnerGuide rating of 80			

END

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MODULE 2A

THERMAL INSULATION COMPLIANCE OPTION

RESOURCE CONSERVATION HOUSE – 2006

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INTRODUCTION

This module describes how the provisions for thermal insulation (under Subsection 12.3.2) can be used as a compliance option to meet the energy efficiency performance requirements for Part 9 houses and residential buildings.

OBJECTIVES

Upon completion of this module, participants will be able to:

- Recognize the application of thermal insulation compliance option [Subsection 12.3.2.]
- Identify the minimum requirements for thermal resistance of insulation
- Classify locations to specific degree-day zones
- Identify the impacts of 9thermal bridging in various types of construction
- Recognize the exceptions to thermal resistance values at roof and ceiling assemblies
- Identify the thermal resistance requirements for log walls, and post, beam, and plank construction
- Identify the insulation requirements for slab-on-ground
- apply different provisions for insulation of foundations before and after December 31, 2008
- Identify the requirements for control of convection currents in masonry construction
- Identify minimum efficiency requirements for furnaces

READ TO THE NEXT STOP.

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APPLICATION OF THE THERMAL INSULATION COMPLIANCE OPTION

Sentence 12.2.1.1.(3) sets out the minimum requirements for Part 9 houses and residential buildings relative to energy efficiency. **Three different compliance options** are offered so that a designer can choose any option to meet the minimum energy efficiency requirements. As per Division B, Sentence 12.2.1.1.(3), any one of clauses (a), (b) or (c) can be applied.

Division B, Sentence 12.2.1.1.(3)

The energy efficiency of a building or part of a building of residential occupancy that is within the scope of Part 9 and is intended for occupancy on a continuing basis during the winter months shall,

(a) Conform to the thermal insulation requirements of Subsection 12.3.2.

(b) Conform to the thermal design requirements of Subsection 12.3.3.

OR

(c) *Provide a rating of 80 or more when evaluated in accordance with NRCan 'EnerGuide for New Houses: Administrative and Technical Procedures'*

A designer can comply with the prescriptive requirements for thermal resistance of insulation set out in Subsection 12.3.2. as one way of providing an energy efficient design if application for a building permit has been made up to December 31, 2011.

All applications for building permits for Part 9 residential buildings submitted after December 31, 2011 will be required to demonstrate that they have the performance level of a rating of 80 when evaluated in accordance to NRCan "EnerGuide for New Houses" as required by Division B, Sentence 12.2.1.2.(3).

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MEASURE OF THERMAL PERFORMANCE OF BUILDING ELEMENTS

Thermal performance of a building element is evaluated in terms of its resistance to heat flow. The thermal resistance of a building element may be expressed in terms of:

- RSI value
- R-value, or
- U-value

RSI (Resistance System International) is a metric measure ($m^2°C/W$) of the thermal resistance, or resistance to heat flow. The higher the RSI value, the higher the insulating capability of the material or system.

The imperial measure of thermal resistance is **R-Value** ($hr\ ft^2°F/BTU$), which is a common measure of insulating capability in the United States, and is still widely understood in Canada. RSI and R-value are related as follows:

$$RSI = R\text{-value} \div 5.678$$

RSI and R-Value are measurements of thermal resistance. Another measure of thermal performance of a building element is in terms of its thermal conductivity. Thermal conductance, often defined as a **U-value** ($W/m^2°C$), is a measurement of the ability of a material to conduct heat.

Thermal conductance is inversely related to thermal resistance. As R-Value or RSI increases, the U-value decreases.

The following figure displays the relationship between the popular measures of insulating capability of building elements:

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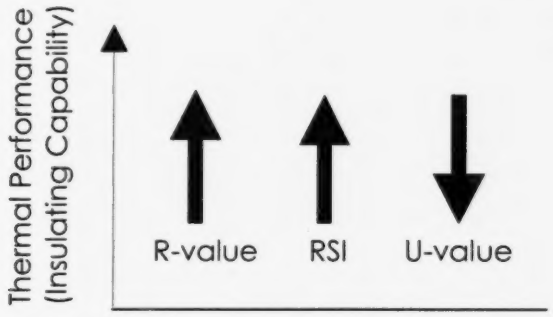

Figure 2A- 1 Relationship Between Measures of Thermal Performance (Building Elements)

STOP

MINIMUM REQUIREMENTS FOR THERMAL RESISTANCE OF INSULATION

Table 12.3.2.1. "Minimum Thermal Resistance of Insulation to be Installed Based on Degree-Day Zones" sets out the minimum thermal resistance values (RSI) for **insulation** that forms part of a building assembly that separates a heated space from the exterior or to an unheated space for Part 9 houses and residential buildings. In addition to the Part 12 requirements, the insulation must conform to the requirements of Division B, Subsection 9.25.

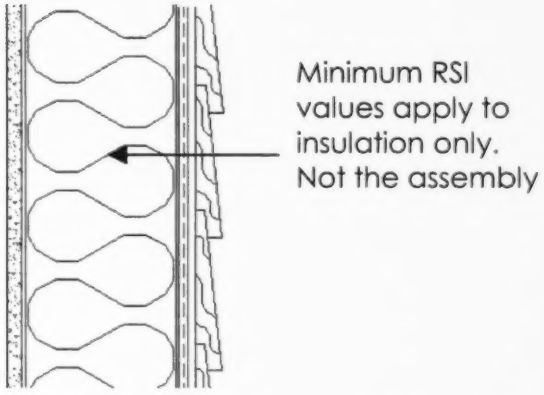

Figure 2A- 2 Minimum RSI Values of Insulation

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As presented earlier, the thermal resistance value (RSI) is a measurement of resistance to heat flow. The higher the resistance value, the slower the rate of heat transfer through the insulating material.

When applying Table 12.3.2.1., the minimum required RSI values for insulation in specific building assemblies are dependant on where the building is located (i.e. town or city) or whether electric space heating is used in the building.

As defined in Division A, Article 1.4.1.2., electric space heating means:

> *...an electric energy source that provides more than 10 per cent of the heating capacity provided for a building and includes,*
>
> *(a) electric resistance unitary baseboard heating,*
>
> *(b) electric resistance unitary cabinet heating,*
>
> *(c) electric resistance ceiling cable or floor cable heating,*
>
> *(d) electric resistance central furnace heating,*
>
> *(e) electric hot water space heating, and*
>
> *(f) air source heat pumps in combination with electric resistance backup heating.*

If **electric heating is used**, the minimum overall RSI values in Column 4 of Table 12.3.2.1. are used, regardless of the geographical location of the building in Ontario.

Otherwise, if **electric space heating is not used**, the minimum RSI values in Table 12.3.2.1. (Column 2 and 3) are dependant on the location of the building and are classified into two zones.

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The thermal resistance values (RSI) are determined based on the energy required to **heat** a building. The amount of energy to heat a house is dependant on the number of heating degree-days. This information can be found for Ontario towns and cities in SB-1, Table 1.2 "Design Data for Selected Locations in Ontario".

For the purposes of determining the minimum thermal resistance value for a building element, a town or city is classified in one of the following two degree-day zones:

Zone 1: Heating Degree-days < 5000/year

Zone 2: Heating Degree-days ≥ 5000/year

STOP

HEATING DEGREE-DAYS

The minimum thermal resistance values (RSI) set out in Table 12.3.2.1. "Minimum thermal Resistance of Insulation to be installed Based on Degree-Day Zones" are dependant on the heating degree-days for the location of the building.

As describes in SB-1, when the average daily outside temperature is 18°C or more, it is assumed that no energy is required for the purposes of these calculations. As such, only the daily temperatures below 18°C contribute to heating degree-days.

The number of annual heating degree-days (HDD) is calculated using the following approach:

$$HDD = \sum_{n=1}^{365} 18 - T_{avg.day\_n}$$

or

$$HDD = (18 - T_{avg.day1}) + (18 - T_{avg.day2}) + ... + (18 - T_{avg.day365})$$

→ $T_{avg.\ day\text{-}n}$ is the average temperature on that day.

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This calculation has been completed for you and can be found in SB-1, Table 1.2. "Design Data for Selected Locations in Ontario" for specific locations in Ontario.

EXAMPLE

What is the number of heating degree-days for three successive winter days having a mean temperature of 4°C on Day 1, −2°C on Day 2 and −4°C on Day 3?

Solution:

$$HDD = \sum_{n=1}^{3} 18 - T_{avg.day\_n}$$

$$HDD = (18 - T_{avg.day1}) + (18 - T_{avg.day2}) + (18 - T_{avg.day3})$$

$$HDD = (18-4) + (18-(-2)) + (18-(-4))$$
$$HDD = 14 + 20 + 22$$
$$HDD = 56$$

COMPLETE THE NEXT EXERCISE

EXERCISE 2A-1

Using SB-1, determine the annual heating degree-days below 18°C for Peterborough.

(a) 5150

(b) 4400

(c) 710

(d) 840

Code Ref.:_____

STOP

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EXAMPLE

Identify the degree-day zone for each of the following locations:

- Sault Ste. Marie
- Pembroke

Solution:

→ Referring to Table 1.2 "Design Data for Selected Locations in Ontario" in SB-1, locate the number of heating degree-days (Column 6):

- Sault Ste. Marie: 5100
- Pembroke: 5000

→ Based on the definition of Zone 1 and Zone 2 from Table 12.3.2.1. "Minimum Thermal Resistance of Insulation to be Installed Based on Degree-Day Zones" of the Code

Zone 1: Heating Degree-days < 5000/year

Zone 2: Heating Degree-days ≥ 5000/year

- Sault Ste. Marie: Zone 2
- Pembroke: Zone 2

COMPLETE THE NEXT THREE EXERCISES

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EXERCISE 2A-2

Identify the heating degree-days (HDD) and the HDD zone for each of the following cities and towns:

City or Town	Heating Degree-Days	HDD Zone
Example: Belleville	**4100**	**1**
Ajax		
Timmins		
Dryden		
Thunder Bay		
Aurora		

Code Ref.:_____

EXERCISE 2A-3

A new 2 storey house having a footprint area of 200 m^2 will be constructed in Sault Ste. Marie and will have electric space heating. The designer chose the thermal insulation compliance option to meet the minimum energy efficiency requirements. What is the minimum required RSI for insulation for each of the following building elements if the building permit application is submitted In 2010?

Exterior walls: _____

Foundation walls: _____

Interior walls: _____

Ceiling below attic: _____

Code Ref.:_____

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EXERCISE 2A-4

A new 200 m^2 house is being designed in Ajax with natural gas heating. What are the minimum RSI values that apply to the insulation in the following building assemblies if the building is being designed using the thermal insulation compliance option?

Building Assembly	Minimum RSI value ($m^2°C/W$)
Basement floor located at 500 mm below grade that does not contain heating piping, tubes, ducts, or cables:	
Ceiling below attic space:	
Exterior Wall:	
Ground floor:	

Code Ref.:_____

STOP

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IMPACT OF THERMAL BRIDGING AND METAL THERMAL BRIDGES

The minimum thermal resistance values identified in Table 12.3.2.1. "Minimum Thermal Resistance of Insulation to be Installed Based on Degree-Day Zones" apply through the insulation only and does not apply at framing or furring elements.

The calculation of thermal resistance, when measured at a stud or furring channel, can be significantly less than the thermal resistance across the insulated portion of the assembly. The effect of thermal resistance at studs and furring channels is known as thermal bridging. A thermal bridge is a material that connects the warm side of the building assembly to the cold side and that has a greater thermally conductivity compared to other adjacent materials.

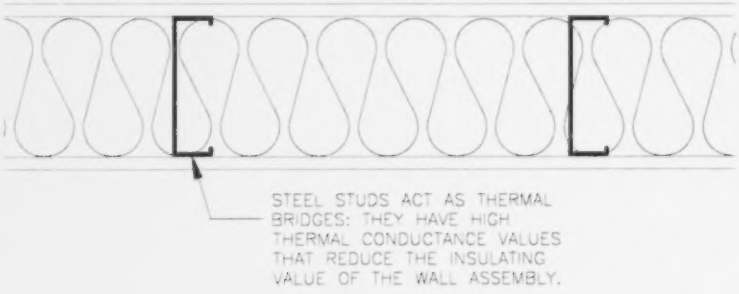
STEEL STUDS ACT AS THERMAL BRIDGES: THEY HAVE HIGH THERMAL CONDUCTANCE VALUES THAT REDUCE THE INSULATING VALUE OF THE WALL ASSEMBLY.

Figure 2A- 3 Steel Studs that Act as Thermal Bridges

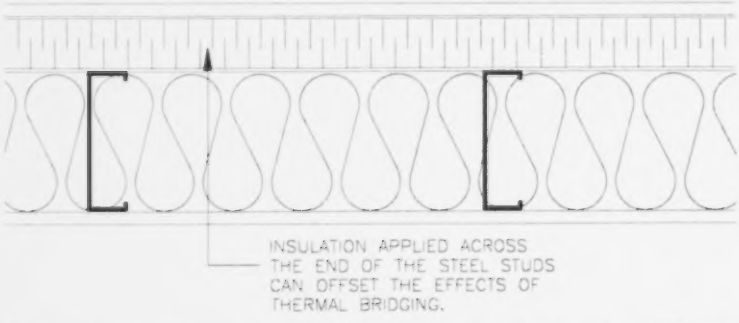

Figure 2A- 4 Example With Insulation Reducing the Effects of Thermal Bridging with Steel Studs

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The thermal resistance values set out in Table 12.3.2.1. "Minimum Thermal Resistance of Insulation to be Installed Based on Degree-Day Zones" do not need to be adjusted to consider the localized thermal bridging effect of **wood** studs.

However, **steel** studs are more thermally conductive than wood studs and reduce the thermal resistance of the building assembly when compared to a similar wood stud framed assembly. The thermal resistance values of Table 12.3.2.1. "Minimum Thermal Resistance of Insulation to be Installed Based on Degree-Day Zones" do not consider metal framing elements that act as thermal bridges.

To compensate for the negative impact of metal framing, the minimum RSI values set out in Table 12.3.2.1. must be increased.

Article 12.3.2.2. sets out provisions to reduce the effects of thermal bridging for insulated portions of a wall. These provisions include an option to increase the RSI values otherwise required by Sentence 12.3.2.1.(4).

Division B, Article 12.3.2.2.

(1) Except for a foundation wall, the insulated portion of a wall that incorporates wood stud framing elements that have a thermal resistance of less than RSI 0.90 shall be insulated to restrict heat flow through the studs by a material providing a thermal resistance at least equal to 25 per cent of the thermal resistance required for the insulated portion of the assembly in Sentence 12.3.2.1.(4).

(2) Except as provided in Sentence (3), the thermal resistance of the insulated portion of a building assembly in Sentence 12.3.2.1.(4) that incorporates metal framing elements, such as steel studs and steel joists, that act as thermal bridges to facilitate heat flow through the assembly, shall be 20 per cent greater than the values shown in Table 12.3.2.1, unless..."

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The 20% increase of the RSI values described in Sentence 12.3.2.2.(2) is **not** required if:

- *"...it can be shown that the heat flow is not greater than the heat flow through a wood frame assembly of the same thickness."* [Division B, Sentence 12.3.2.2.(2)]

OR

- Metal thermal bridges are insulated by a material having an RSI of 25% of the values set out in Table 12.3.2.1. [Division B, Sentence 12.3.2.2.(3)]

COMPLETE THE NEXT EXERCISE

EXERCISE 2A-5

A new 200 m^2 house will be built in Guelph. If walls are constructed using steel studs are proposed in lieu of wood stud framing elements (in accordance with Sentence 12.3.2.2.(2)), what is the minimum RSI value for insulation of the following building elements:

Building Element	Minimum RSI Value ($m^2°C/W$)
Basement floor located at 500 mm below grade that does not contain heating piping, tubes, ducts, or cables:	
Ceiling below attic space:	
Exterior Wall:	
Ground floor:	

Code Ref.:_____

STOP

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EXCEPTIONS TO THERMAL RESISTANCE VALUES REQUIREMENTS

The minimum thermal resistance (RSI) values set out in Table 12.3.2.1. "Minimum Thermal Resistance of Insulation to be Installed Based on Degree-Day Zones" apply to most building elements. However, there are some exceptions in determining the RSI value for the following building elements:

- Roof and ceiling assemblies (Module 2A)
- Log wall construction and, posts, beam, and plank construction. (Module 2A)
- Foundation walls (Module 2A)
- Windows/Doors (Module 2B)

These exceptions are discussed below. The thermal resistance of windows and doors will be discussed in Module 2B.

Also, under Sentence 12.3.2.1.(3) **reflective surfaces are not** to contribute to the RSI value of the insulation. For example foil back insulation will not have an increased RSI because of the reflective surface. Only the insulation material will contribute to the thermal resistance value.

THERMAL RESISTANCE REQUIREMENTS FOR ROOF AND CEILING ASSEMBLIES

The minimum thermal resistance values set out in Table 12.3.2.1. "Minimum Thermal Resistance of Insulation to be Installed Based on Degree-Day Zones" for roofs and ceilings exposed to the exterior or to unheated spaces may be reduced near eaves.

Division B, Sentence 12.3.2.3.(1)

> *...to the extent made necessary by the roof slope and required ventilation clearances...*

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However, a minimum RSI value of **at least 2.1 $m^2°C/W$** is required for insulation installed directly above the inner surface of the exterior wall.

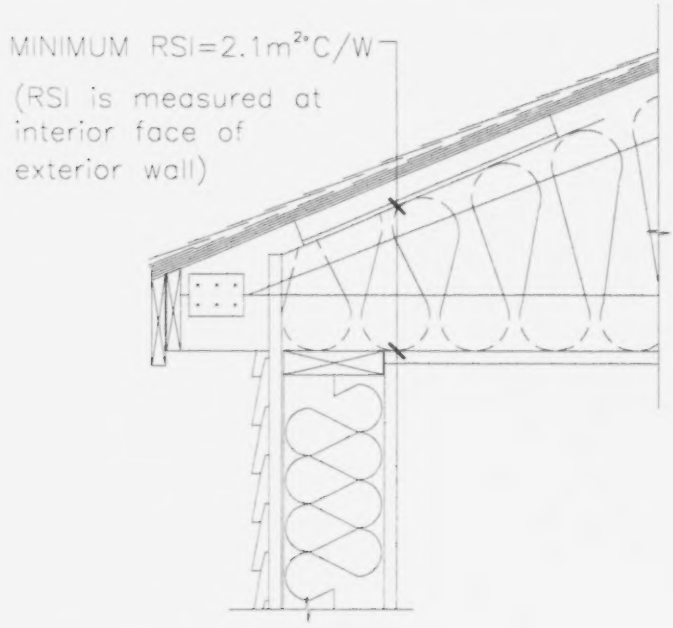

Figure 2A- 5 Reduction in Thermal Insulation due to Roof Slope and Required Ventilation

STOP

THERMAL RESISTANCE REQUIREMENTS FOR LOG WALL CONSTRUCTION AND POST, BEAM AND PLANK CONSTRUCTION

Article 12.3.2.9. sets out the **minimum** thermal resistance requirements for log wall construction and post, beam and plank construction.

Division B, Sentence 12.3.2.9.(1)

> *...log wall construction and post, beam and plank construction shall have a minimum thermal resistance of RSI 2.1 for the total assembly.*

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However, the minimum thermal resistance value of 2.1 $m^2°C/W$ is permitted to be reduced to an RSI of 1.61 $m^2°C/W$ as per Division B, Sentence 12.3.2.9.(2) as follows:

Division B, Sentence12.3.2.9.(2)

The thermal resistance value in Sentence (1) for the total wall assembly may be reduced to not less than RSI 1.61 if,

(a) the thermal resistance of insulation for the exposed roof or ceiling required in Table 12.3.2.1. is increased by an amount equivalent to the reduction permitted in this Sentence

AND

(b) for log walls, the logs have tongue-and-groove or splined joints.

Also, the minimum thermal resistance value of 2.1 $m^2°C/W$ is **not required** for milled log walls by Division B, Sentence 12.3.2.9.(3).

Division B, Sentence 12.3.2.9.(3)

*Where milled log walls are installed, the thermal resistance value in Sentence (1) for the total wall assembly does **not** apply if,*

(a) the mean thickness of each log is not less than 150 mm,

(b) the thermal resistance of insulation for the exposed roof or ceiling required in Table 12.3.2.1. is increased by 0.53, and

(c) the logs have tongue-and-groove or splined

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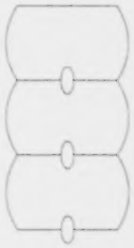

Figure 2A- 6 Splined Joint

EXAMPLE

A new 200 m^2 log house with natural gas heating will be constructed in Orillia. Using the provisions of 12.3.2., what is the minimum required RSI value of the total wall assembly if the each milled log will have an average thickness of at least 200 mm and have splined joints, and the exposed roof will be insulated with insulation having an RSI of 5.0 $m^2°C/W$?

Solution:

→ Sentence 12.3.2.9.(1) requires an RSI of 2.1 $m^2°C/W$ for total wall assemblies.

→ However, an RSI 2.1 $m^2°C/W$ can be reduced to as low as 1.6 $m^2°C/W$ if the 3 conditions of Sentence 12.3.2.9.(3) are met.

- 2 conditions are met: (a) Each milled log has a mean thickness of at least 150 mm, and (b) the logs have splined joints.

- 1 condition is not met: (c) Insulation values in Table 12.3.2.1. for exposed roof or ceilings must be increased by 0.53 $m^2°C/W$. Therefore, insulation must have an RSI of 5.46 $m^2°C/W$.

Required: 5.46 $m^2°C/W$ > Proposed: 5.0 $m^2°C/W$)

→ Therefore, the minimum RSI value of the total wall assembly is 2.1 $m^2°C/W$

STOP

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COMPLETE THE NEXT EXERCISE

EXERCISE 2A-6

A new log house heated with natural gas will be constructed in 2010 in Kenora. The designer wants to apply the provisions of Subsection 12.3.2. as a compliance option to meet the energy efficiency requirements. What is the minimum RSI value for an exposed roof in order to have an RSI value of 1.8 $m^2°C/W$ for the total wall assembly?

(a) 7.00 $m^2°C/W$

(b) 5.23 $m^2°C/W$

(c) 4.93 $m^2°C/W$

(d) 4.63 $m^2°C/W$

Code Ref.: _____

STOP

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INSULATION OF SLAB ON GROUND

Table 12.3.2.1. "Minimum Thermal Resistance of Insulation to be Installed Based on Degree-Day Zones" contains minimum RSI values for slab-on-ground. These values are applicable as further described by Division B, Article 12.3.2.4.

The RSI values from Table 12.3.2.1. are permitted to be reduced in accordance with Division B, Sentence 12.3.2.4.(7) by 50% as follows.

Division B, Sentence 12.3.2.4.(7)

> *...if the underside of the entire slab-on-ground is insulated.*

However, as per Division B, 12.3.2.4.(6), the insulation installed around concrete slab-on-ground is required to extend at least 600 mm below the ground level.

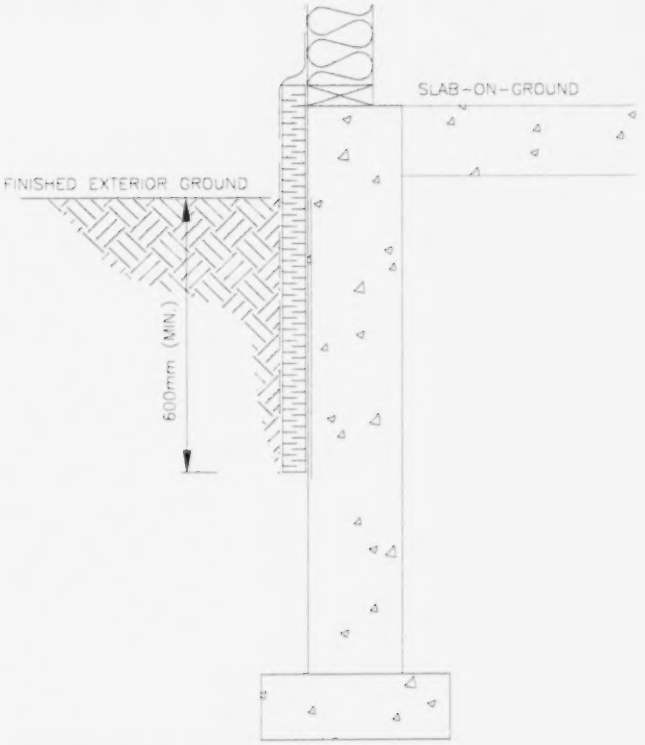

Figure 2A- 6 Insulation Installed Vertically for Slab-on-Ground

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EXAMPLE

A new house is being designed in Halton Hills, Ontario. What is the minimum thermal resistance value for a basement concrete floor slab that will be installed at 1200 mm below grade when applying the thermal insulation compliance option?

Solution:

→ The RSI requirements are set out in Table 12.3.2.1. "Minimum Thermal Resistance of Insulation to be Installed Based on Degree-Day Zones"

- Basement floor slabs located more than 600 mm below grade do not have minimum RSI values.

→ The basement floor slab does not have any minimum requirements for RSI values.

COMPLETE THE NEXT EXERCISE

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EXERCISE 2A-7

A new house is being designed in Halton Hills, Ontario with a gas-fired forced air heating system. What is the minimum thermal resistance of the insulation installed around the perimeter of the slab-on-ground when applying the thermal insulation compliance option? The slab-on-ground contains heating pipes, and the slab will be located 300 mm below grade.

(a) 1.76 $m^2°C/W$

(b) 1.41 $m^2°C/W$

(c) 0.88 $m^2°C/W$

(d) 0.71 $m^2°C/W$

_____

_____

_____

_____

_____

Code Ref.: _____

STOP

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INSULATION OF FOUNDATION WALLS

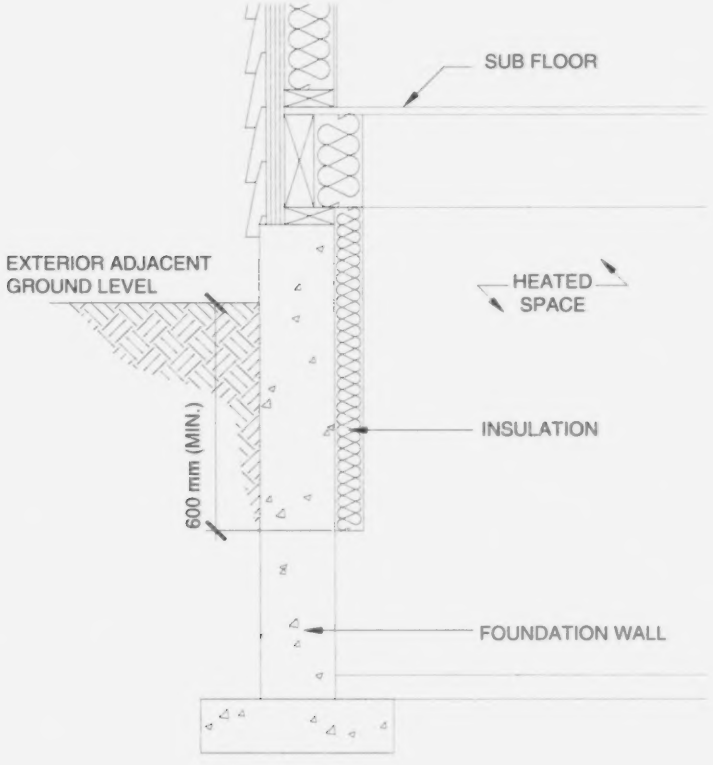
Table 12.3.2.1. "Minimum Thermal Resistance of Insulation to be Installed Based on Degree-Day Zones" contains a minimum required RSI value for foundation walls. These values are applicable as further described by Division B, Article 12.3.2.4.

Building permits submitted up to December 31, 2008 are required to meet the following.

Division B, Sentence 12.3.2.4.(2)

> *Foundation walls enclosing heated space shall be insulated from the underside of the subfloor to not less than 600 mm below the adjacent exterior ground level.*

Insulation installed on exterior walls is required to be installed to a minimum depth of 600 mm below the adjacent exterior ground level.



(a)

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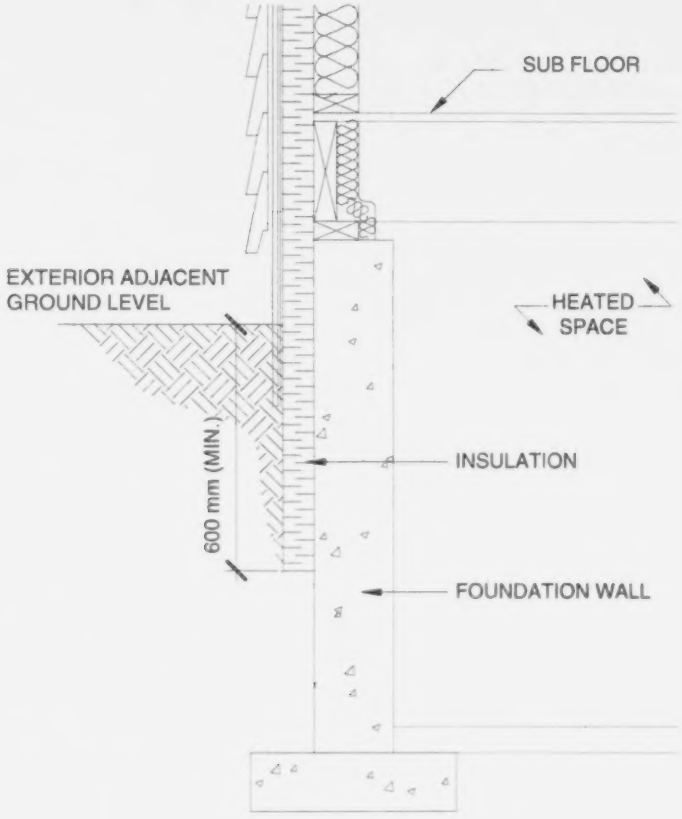

(b)

Figure 2A- 7 Insulation Requirements for Foundation Walls Designed up to December 31, 2008 (a) Insulation Installed on the Interior (b) Insulation Installed on the Exterior

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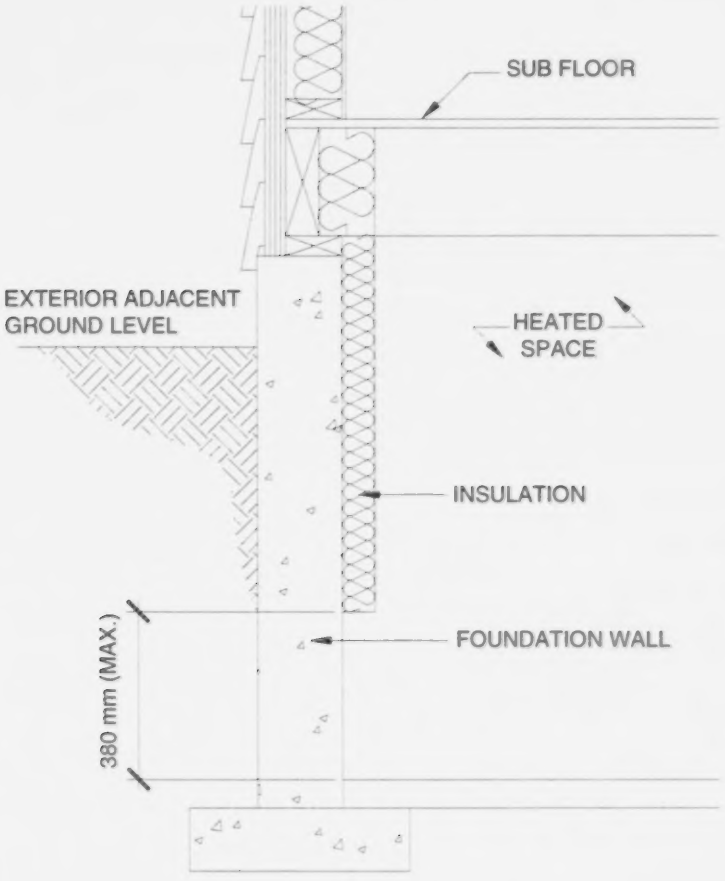
Building permits submitted after December 31, 2008 are required to meet the following.

Division B, Sentence 12.3.2.4.(4)

Foundation walls enclosing heated space shall be insulated from the underside of the subfloor to not more than 380 mm above the finished floor level of the basement.

Insulation installed on exterior walls is required to be installed to within 380 mm above the finished floor to limit excessive energy consumption.



(a)

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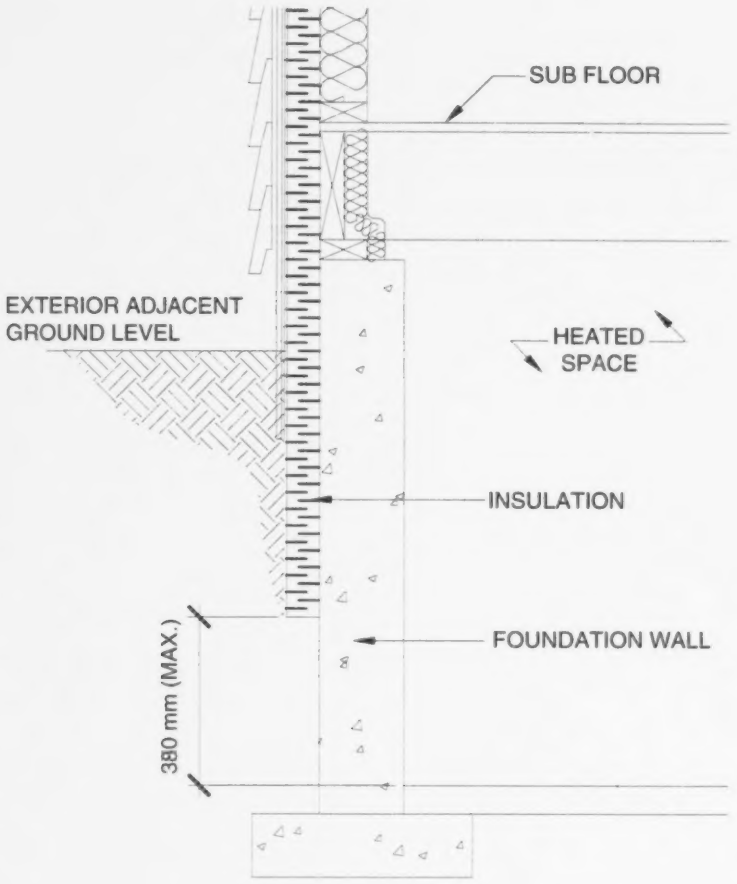

(b)

Figure 2A- 8 Insulation Requirements for Foundation Walls Designed After December 31, 2008 (a) Interior insulation (b) Exterior Insulation

The installation of the insulation around the foundation wall can be installed on the interior, exterior, or a combination of interior and exterior to provide the minimum performance.

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CONTROLLING CONVECTION CURRENTS IN MASONRY WALLS

Convective movement of air can result when the surface of a material is a different temperature than the adjacent air. Convective airflow can reduce the thermal performance of a building and can carry moisture to problematic locations.

To limit convection currents in the core spaces of masonry units, appropriate air and surface temperatures must be maintained and moisture condensation must be limited. To do so, **foundation walls** constructed of hollow masonry units are required to conform to Sentence 12.3.2.4.(8).

Division B, Sentence 12.3.2.4.(8)

> *If a foundation wall is constructed of hollow masonry units, one or more of the following shall be used to control convective air currents in the core spaces,*
>
> *(a) Filling the core spaces*
>
> *(b) at least one row of semi-solid blocks at or below grade*
>
> *OR*
>
> *(c) other similar methods.*

These requirements are in addition to the minimum requirements for the insulation of foundation walls.

Masonry walls constructed of hollow units that penetrate the ceiling must be sealed at or near the adjacent roof to prevent convection currents from entering the attic or roof space in accordance with on of the provisions of Sentence 12.3.2.4.(9).

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Division B, Sentence 12.3.2.4.(9)

Masonry walls of hollow units that penetrate the ceiling shall be sealed at or near the ceiling adjacent to the roof space to prevent air within the voids from entering the attic or roof space by,

(a) capping with masonry units without voids, or

(b) installation of flashing material extending across the full width of the masonry.

Also note that Sentence 9.20.8.1.(1) requires a similar feature at the top of hollow masonry walls.

STOP

EQUIPMENT EFFICIENCY

In addition to conforming to the thermal insulation compliance option for energy efficiency, all Part 9 residential buildings are required to meet minimum furnace efficiencies.

The minimum furnace fuel utilization efficiency requirements are set out in Article 12.3.1.2. The efficiency requirements are based on the fuel source of the furnace.

Table 12.3.1.2 "Furnace Minimum Annual Fuel Utilization Efficiency" prescribes minimum annual fuel utilization efficiency ratings for natural gas, propane and oil furnaces.

COMPLETE THE NEXT EXERCISE

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EXERCISE 2A-8

Using Table 12.3.1.2., what is the minimum annual fuel utilization efficiency of a propane furnace that will be installed in a 185 m^2 house?

_____

_____

_____

_____

END

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MODULE 2B

THERMAL PERFORMANCE
WINDOWS AND DOORS

RESOURCE CONSERVATION HOUSE – 2006

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Allow 1.0 hour for this module.

INTRODUCTION

This module describes how the provisions for thermal insulation can be used as a compliance option to meet the energy efficiency performance requirements for windows and doors for Part 9 houses and residential buildings.

OBJECTIVES

Upon completion of this module, participants will be able to:

- Recognize the application of thermal insulation compliance option (Subsection 12.3.2.)
- Identify the thermal conductance requirements for windows and glazing in sliding doors
- Identify the thermal conductance requirements for doors
- Identify the impact of electric space heating on doors and glazing in dwelling units

READ TO THE NEXT STOP.

Instruct participants to read to the STOP (allow 5 minutes)

APPLICATION OF THE THERMAL INSULATION COMPLIANCE OPTION

A designer can comply with the prescriptive requirements for thermal resistance of insulation set out in Subsection 12.3.2. as one way of providing an energy efficient design if application for a building permit has been made up to December 31, 2011.

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All applications for building permits for Part 9 houses and residential buildings submitted after December 31, 2011 will be required to demonstrate that the buildings has the performance level of a rating of 80 when evaluated in accordance to NRCan "EnerGuide for New Houses" as required by Division B, Sentence 12.2.1.2.(3).

STOP

MEASURE OF THERMAL PERFORMANCE OF GLAZING AND DOORS

Instruct participants to read to the STOP, and complete exercises (allow 15 minutes, and 5 minutes for discussion and answers)

Whereas the thermal performance of walls, roofs and foundations are measured in terms of **thermal resistance**, the thermal performance of windows and doors are measured in terms of **thermal conductance**.

Thermal conductance is a measure of heat transfer through a material or an assembly.

Thermal performance of glazing and doors may be expressed in terms of:

- RSI value
- R-value
- Overall U-value/Coefficient of heat transfer, or
- Energy rating

As described in Module 2A, RSI, R-value and U-value are a measure of thermal resistance or conductance for building elements. This same principal applies to glazing. When applying the U-value to windows, overall U-value applies and all elements of the window assembly are considered, including the window frame and glazing, air space or argon-fill, etc.

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In addition to thermal resistance, glazing can also be represented in terms of overall U-value or **coefficient of heat transfer** ($W/m^2°C$), which is a measure of thermal conductance and is the inverse of the RSI value.

Whereas an increase in RSI represents an increase in the thermal performance of a material, an increase in thermal conductance represents a decrease in thermal performance of the material.

Materials with a higher relative thermal conductance have a lower insulation capability.

$$\text{Coefficient of heat transfer} = \frac{1}{RSI}$$

The **energy rating** (W/m^2) is a rating system adopted by CSA A440.2., where the energy rating represents the following:

Energy rating = Positive solar gains
- transmission losses
- infiltration losses

The coefficient of heat transfer and the energy rating for windows and sliding doors are determined using the methods described in CAN/CSA-A440.2, "Energy Performance Evaluation of Windows and Sliding Glass Doors."

Window manufacturers usually undertake the determination of these factors.

It is important to verify that the information is provided with the same units as shown in the Code. Manufacturers typically provide thermal performance properties of windows systems, but they are often provided in measures different from the coefficient of heat transfer.

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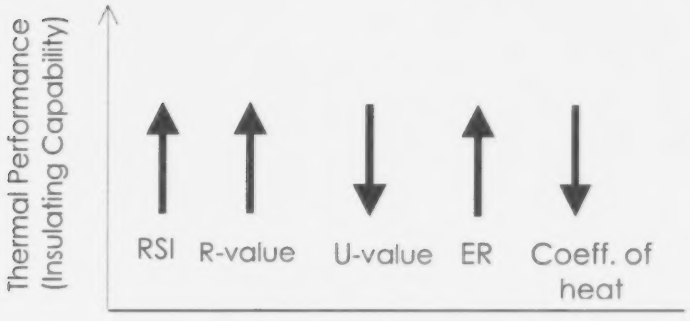
RSI, R-value, and U-value have previously been discussed in this Module. Often, manufacturers identify a U-value as an indicator of thermal performance. The U-value (inverse of R-value) is also a measure of thermal conductance of a building element.

The following figure displays the relationships between the popular measures and the relative thermal performance and insulating capability of building elements:



2B-1 Relationship Between Measures of Thermal Performance (Building Elements)

STOP

Instruct participants to read to the STOP, and complete exercises (allow 10 minutes, and 5 minutes for discussion of answers)

THERMAL CONDUCTANCE REQUIREMENTS FOR WINDOWS AND SLIDING DOORS

The minimum thermal performance requirements for glazing are set out in Division B, Articles 12.3.2.6. "Thermal Resistance of Windows" and 12.3.2.7. "Minimum Thermal Resistance of Doors".

Article 12.3.2.8. sets out the maximum thermal conductance for doors and glazing that separate heated spaces from unheated spaces in houses that use electric space heating.

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The Code prescribes conductance limits in terms of coefficient of heat transfer and energy rating.

If applying the thermal insulation compliance option for **windows or sliding glass doors**, generally, glazing must meet one of the following:

Excerpts from Division B, Sentence 12.3.2.6.(1) and 12.3.2.7.(2)

(a) An overall coefficient of heat transfer of not more than 2.0 W/m²°C

OR

(b) An energy rating of not less than,

(i) 17 for operable windows and sliding doors

(ii) 27 for fixed windows

Glazing in windows and sliding glass doors that separate **electrically heated spaces** from unheated spaces have more stringent performance requirements in dwelling units:

Division B, Article 12.3.2.8.

(a) An overall coefficient of heat transfer of not more than 1.6 W/ m²°C

OR

(b) An energy rating of not less than

(i) 25 for operable windows and sliding glass doors

(ii) 35 for fixed windows.

In addition, basement windows that incorporate a load-bearing structural frame are required to be double glazed with low-E coating.

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EXAMPLE

A new house with electric space heating is being designed in a Zone 1 (less than 5000 heating degree-days). What is the minimum energy rating of an operable window if the building permit application is submitted in 2009?

Solution:

→ Determine applicable Article for thermal performance of windows

- Article 12.3.2.6. applies to all windows
- However, Article 12.3.2.8. applies to doors and glazing with electric heating
- Since the provisions in Article 12.3.2.8. are more specific than the general provisions of Article 12.3.2.6. the provisions of Article 12.3.2.8. apply.

→ Determine minimum energy rating.

- Sub clause 12.3.2.8.(2)(b)(i) requires all operable windows in an electrically heated house to have an energy rating of 25.

→ Therefore, the minimum energy rating of an operable window is 25.

STOP

(Allow 10 minutes to complete next exercise)

COMPLETE THE NEXT EXERCISE

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Exercise 2B-1

Thermal performance can be evaluated based on the maximum coefficient of heat transfer and the minimum energy rating.

EXERCISE 2B-1

A new 200 m² 2 storey house with natural gas heating is being designed in Mississauga using the thermal insulation option. Determine the **minimum thermal performance** requirements (i.e. overall coefficient of heat transfer and energy rating) for the following glazing if the building permit application is submitted prior to 2010.

(a) Sliding doors:

Max. coeff. of heat transfer: 2.0 W/ $m^2 \cdot °C$

Min Energy rating: 17
Sentence 12.3.2.7.(2)

(a) Glazed sliding doors provided for ground floor rooms

_____

_____

Code Ref.:_____

(b) Fixed windows:

Max. coeff. of heat transfer: 2.0 W/ $m^2 \cdot °C$

Min Energy rating: 27

Sentence 12.3.2.6.(1) and Subclause 12.3.2.6.(1)(b)(ii)

(b) Fixed windows provided for rooms on the second floor

_____

_____

Code Ref.:_____

(c) Glazing in operable windows:

Max. coeff. of heat transfer: 2.0 W/ $m^2 \cdot °C$

Min Energy rating: 17

Sentence 12.3.2.6.(1) and Subclause 12.3.2.6.(1)(b)(i)

(c) Operable windows provided in living areas on the ground floor.

_____

_____

Code Ref.: _____

STOP

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Instruct participants to read to the STOP (allow 5 minutes)

DOORS THERMAL CONDUCTANCE REQUIREMENTS

Table 12.3.2.1. "Minimum Thermal Resistance of Insulation to be Installed Based on Degree-Day Zones" does not include the minimum thermal resistance values for doors.

The minimum thermal performance for doors are set out generally in Sentence 12.3.2.7.(1) and 12.3.2.8.(1) specifically for sliding doors in dwelling units where the sliding doors separate heated spaces from unheated spaces.

Sentence 12.3.2.7.(1) is applicable to all doors that separate heated space from the outside, except doors on enclosed unheated vestibules and cold cellars or where storm doors are provided.

As per Sentence 12.3.2.7.(1), the non-glazed (opaque) portion of doors are required to have a minimum thermal resistance of not less than RSI 0.7. The glazed portions of doors do not have any thermal conductance requirements.

END

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MODULE 3A

THERMAL DESIGN COMPLIANCE OPTION

RESOURCE CONSERVATION HOUSE – 2006

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INTRODUCTION

This module describes how the provisions for thermal design (under Subsection 12.3.3.) can be used as a compliance option to meet the energy efficiency performance requirements for Part 9 residential buildings and houses.

The thermal design option recognizes the contribution of all elements in the building assembly. This design option differs from the thermal insulation design option described in Module 2A since the thermal insulation compliance option only addresses the thermal resistance value of the insulation.

The thermal design compliance option described in this Module and set out in Subsection 12.3.3. is required to be designed by an architect and/or by a professional engineer, as described in Division C, Sentence 1.2.1.1.(6).

OBJECTIVES

Upon completion of this module, participants will be able to:

- Identify applicable Part 9 requirements for materials, crawl spaces, roof spaces, ventilation and HVAC
- Apply Table 12.3.3.3. for determining minimum thermal resistance of building assemblies
- Recognize the exceptions when determining the minimum thermal resistance of building assemblies
- Calculate and apply factors to adjust thermal insulation requirements for thermal bridging of steel stud wall assemblies

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- Identify the option to reduce thermal resistance of roof and ceiling assemblies by consideration of total calculated heat loss
- Recognize the differences for required insulation of foundations before and after January 1, 2009
- Identify the thermal insulation requirements for slab-on-ground
- Identify minimum efficiency requirements for furnaces.

READ TO THE NEXT STOP.

APPLICATION OF THE THERMAL DESIGN COMPLIANCE OPTION

Sentence 12.2.1.1.(3) sets out the minimum requirements for Part 9 houses and residential buildings relative to energy efficiency. **Three different compliance options** are offered so that a designer can choose any option to meet the minimum energy efficiency requirements. As per Division B, Sentence 12.2.1.1.(3), any one of clauses (a), (b) or (c) can be applied.

Division B, Sentence 12.2.1.1.(3)

The energy efficiency of a building or part of a building of residential occupancy that is within the scope of Part 9 and is intended for occupancy on a continuing basis during the winter months shall,

(a) Conform to the thermal insulation requirements of Subsection 12.3.2.

(b) Conform to the thermal design requirements of Subsection 12.3.3.

OR

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(c) Provide a rating of 80 or more when evaluated in accordance with NRCan 'EnerGuide for New Houses: Administrative and Technical Procedures'

A designer can apply the prescriptive thermal design requirements set out in Subsection 12.3.3. as one way of providing an energy efficient design if application for a building permit has been made up to December 31, 2011.

All permit applications for houses and Part 9 residential buildings submitted after December 31, 2011 will be required to meet the performance level that is equal to a rating of 80 when evaluated in accordance to NRCan "EnerGuide for New Houses".

PART 9 REQUIREMENTS ARE STILL APPLICABLE!

Generally, building assemblies are required to meet the following minimum Part 9 requirements:

Division B, Article 12.3.3.2.

(1) ... thermal insulation and vapour barrier protection shall conform to Section 9.25.

(2) Foamed plastic thermal insulation shall be protected as described in Article 9.10.17.10.

(3) Crawl spaces shall conform to Section 9.18.

(4) Roof spaces shall conform to Section 9.19.

(5) Ventilation requirements shall conform to Section 9.32.

(6) Heating and air-conditioning requirements shall conform to Section 9.33.

The above noted Part 9 provisions apply in addition to the energy efficiency provisions of Part 12.

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The thermal design compliance option, discussed in this Module, takes into consideration the thermal effects of different elements of the building assembly, such as sheathing or gypsum board.

STOP

MINIMUM THERMAL RESISTANCE FOR BUILDING ASSEMBLIES

The thermal design compliance option takes into consideration the insulating contribution from all elements of the building assembly. This approach differs from the thermal insulation compliance option described in Module 2A, which only considers the thermal properties of the insulation that is part of an assembly.

Table 12.3.3.3. "Minimum Thermal Resistance of Building Assemblies Based on Degree-Day Zones" sets out the minimum thermal resistance values (RSI) for building **assemblies** separating a heated space from an unheated space or the exterior.

RSI is the acronym for "Resistance Système International", which is the metric equivalent of R-value and is expressed in terms of $m^2°C/W$.

The ***minimum RSI values for building assemblies set out in Table 12.3.3.3.*** "Minimum Thermal Resistance of Building Assemblies Based on Degree-Day Zones" apply through the portions of the building assembly at locations other than where there is:

- Framing

Or

- Furring

The effect of framing and furring channels is addressed separately by considering their contribution as thermal bridges. This effect will be considered later in this Module.

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Each building element (such as insulation or interior gypsum board or exterior sheathing) contributes to the overall RSI value of the assembly and has its own RSI value. The overall RSI value of the building assembly is the sum of the RSI values of each building element in the building assembly.

The overall RSI value of the building assembly does not consider furring or spacers, therefore the RSI value is calculated at a location where furring or spacers are not provided.

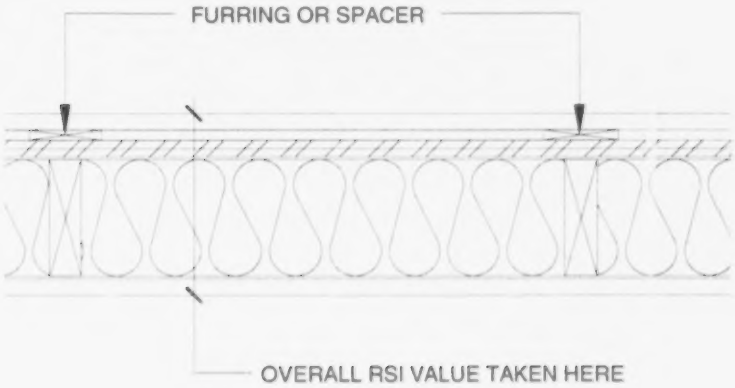

Figure 3A- 1 Furring or Spacers not Considered for RSI of Assembly

When applying Table 12.3.3.3. "Minimum Thermal Resistance of Building Assemblies Based on Degree-Day Zones", the minimum required RSI values for specific building assemblies are dependant on where the building is geographically located (i.e. town or city) or whether electric space heating is used in the building.

If **electric space heating is used**, the minimum overall RSI values in Column 4 of Table 12.3.3.3. "Minimum Thermal Resistance of Building Assemblies Based on Degree-Day Zones" are used. These requirements are generally more stringent.

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Otherwise, if **electric heating is not used**, the minimum RSI values in Table 12.3.2.1. (Column 2 and 3) are dependant on the location of the building and are classified into two zones.

The thermal resistance values (RSI) are determined based on the energy required to **heat** a building. The amount of energy to heat a house is dependant on the number of heating degree-days. This information can be found for Ontario towns and cities in SB-1, Table 1.2 "Design Data for Selected Locations in Ontario".

For the purposes of determining the minimum thermal resistance value for a building element, a town or city is classified in one of the following two degree-day zones:

Zone 1: Heating Degree-days < 5000/year

Zone 2: Heating Degree-days ≥ 5000/year

However, the minimum RSI values for the **assemblies** described in Table 12.3.3.3. "Minimum Thermal Resistance of Building Assemblies Based on Degree-Day Zones" are different from the minimum RSI values for **insulation** in Table 12.3.2.1. "Minimum Thermal Resistance of Insulation to be Installed Based on Degree-Day Zones" which applies when the thermal insulation compliance option is used (Module 2A).

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HEATING DEGREE-DAYS

The minimum thermal resistance values (RSI) found in Table 12.3.3.3. "Minimum Thermal Resistance of Building Assemblies Based on Degree-Day Zones" considers the energy required to heat a building.

Except for buildings with electric space heating, the RSI valves for the assembly are dependant on the number of heating degree-days found in SB-1, Table 1.2. "Design Data for Selected Locations in Ontario"

> Note: Refer to Module 2A to review the determination of heating degree-days

EXAMPLE

An Architect is proposing the following exterior wall section for a new house built in Cornwall, Ontario. Does this wall meet the minimum design requirements for thermal resistance based on the application of the thermal design compliance option and Table 12.3.3.3. "Minimum Thermal Resistance of Building Assemblies Based on Degree-Day Zones"?

Assembly:

Exterior cladding: RSI 0.2
Exterior sheathing: RSI 0.1
Insulation: RSI 3.5
Interior sheathing: RSI 0.1

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Solution:

→ From SB-1, Table 1.2, Cornwall has 4350 annual heating degree-days. This number corresponds to Zone 1.

→ Referring to Table 12.3.3.3. an exterior wall assembly for a Part 9 house must have an RSI of at least 3.8

→ The thermal resistance value of the assembly is the sum of all the individual elements.

- RSI_{Total}= 0.2 + 0.1 + 3.5 + 0.1
- RSI_{Total}= 3.9 $m^2°C/W$

→ Therefore the proposed wall meets the minimum thermal resistance requirements for an exterior wall.

STOP

COMPLETE THE NEXT EXERCISE

EXERCISE 3A-1

A new 2 storey house having a footprint area of 250 m^2 will be constructed in Stratford, Ontario. The building permit will be submitted in 2009. The heating system will be natural gas. What is the minimum RSI for the exterior wall assembly and the interior floor assembly of the second floor?

_____

_____

_____

_____

Code Ref.:_____

STOP

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EXCEPTIONS TO THERMAL RESISTANCE VALUES FOR BUILDING ASSEMBLIES

The minimum thermal resistance (RSI) values set out in Table 12.3.3.3. "Minimum Thermal Resistance of Building Assemblies Based on Degree-Day Zones" apply to most building assemblies. However, there are some exceptions and other considerations in determining the minimum RSI value. Some of these exceptions are discussed in this Module, others are addressed in subsequent Modules.

Exceptions apply for:

- Metal thermal bridges (Module 3A)
- Roof and ceiling assemblies only at edges (Module 3A)
- Foundation walls(Module 3A)
- Slab-on-ground (Module 3A)
- Reduction of thermal resistance (Module 3A)
- Windows and glazing (Module 3B)
- Doors (Module 3B)
- Air Infiltration (Module 3C)

METAL THERMAL BRIDGES

As previously noted, the minimum thermal resistance values that are identified in Table 12.3.3.3. "Minimum Thermal Resistance of Building Assemblies Based on Degree-Day Zones" apply through the portion of the assembly that does not include framing and furring. The calculation of thermal resistance, when measured at a stud or furring channel can be significantly less than the thermal resistance across the insulation portion of the assembly. The effect on thermal resistance of studs and furring channels is known as thermal bridging. A thermal bridge is a material that

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connects the warm side of the building assembly to the cold side and that has a greater thermal conductivity compared to other materials.

The thermal resistance values set out in Table 12.3.3.3. "Minimum Thermal Resistance of Building Assemblies Based on Degree-Day Zones" do not need to be adjusted to consider the localized thermal bridging effect of **wood** studs.

However, **steel** studs are more thermally conductive than wood studs and reduce the thermal resistance of the building assembly when compared to a similar wood stud framed assembly. The thermal resistance values of Table 12.3.3.3. "Minimum Thermal Resistance of Building Assemblies Based on Degree-Day Zones" do not consider metal framing elements that act as thermal bridges.

To compensate for the negative impact of metal framing, the minimum RSI values set out in Table 12.3.3.3. must be increased.

Division B, Sentence 12.3.3.4.(1)

> *... the thermal resistance of the insulated portion of a building assembly that incorporates metal framing elements, such as steel studs and steel joists, that act as thermal bridges ... shall be 20 per cent greater than the values shown in Table 12.3.3.3....*

The 20% increase of the RSI values is not required if:

- The heat flow through the portion with the metal thermal bridge **is not greater** than the heat flow through a wood thermal bridge of a building assembly of the same thickness. (Division B, Sentence 12.3.3.4.(1))

OR

- metal thermal bridges are insulated by a material having an RSI of 25% of the values set out in Table 12.3.3.3. (Division B, Sentence 12.3.3.6.(1))

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ROOF AND CEILING ASSEMBLIES THERMAL RESISTANCE REQUIREMENTS

The minimum thermal resistance values set out in Table 12.3.3.3. "Minimum Thermal Resistance of Building Assemblies Based on Degree-Day Zones" and in Article 12.3.3.4. for roofs and ceilings exposed to the exterior or to unheated spaces may be reduced near eaves "*...to the extent made necessary by the roof slope and required ventilation clearances...*" as per Division B, Sentence 12.3.3.7.(1).

However, a minimum RSI of **at least 2.1 m²°C/W** is required for assemblies installed directly above the inner surface of the exterior wall.

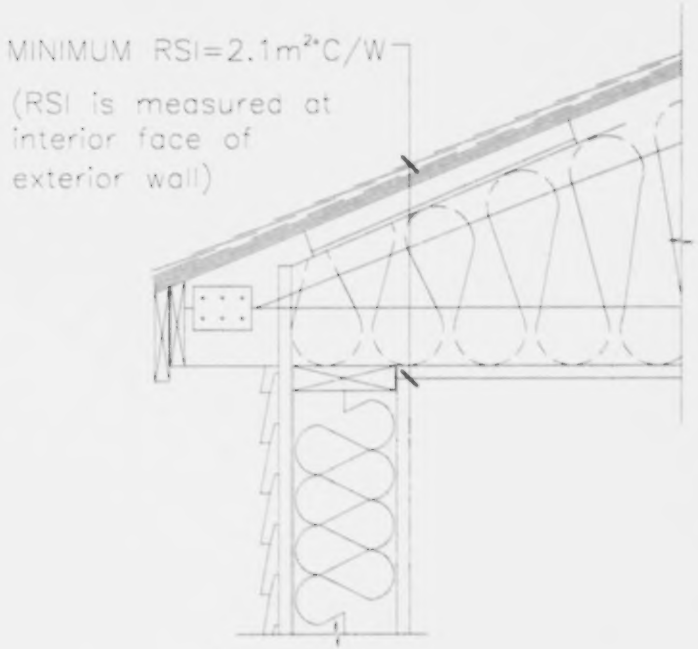

Figure 3A- 2 Reduction in Thermal Insulation Due to Roof Slope and Required Ventilation

COMPLETE THE NEXT EXERCISE

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EXERCISE 3A-2

A new Part 9 house will be designed in conformance with the thermal design compliance option. The new building will be constructed in Cobourg, what is the minimum RSI value for an exposed roof assembly at the following locations:

(a) Near eaves, measured at the inner surface of the exterior wall

_____

Code Ref.:_____

(b) All other locations of the roof assembly

_____

Code Ref.:_____

STOP

INSULATION OF FOUNDATION WALLS

Table 12.3.3.3. "Minimum Thermal Resistance of Building Assemblies Based on Degree-Day Zones" contains a minimum required RSI value for foundation walls enclosing heated space. These values are applicable as further described by Division B, Article 12.3.3.9.

The requirements for insulation of foundation walls for the thermal design compliance option are the same requirements set out in the thermal insulation compliance option described in Module 2A.

Refer to Module 2A for the minimum requirements of Insulation of Foundation Walls

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EXAMPLE

A new 2 storey 200 m^2 house is being designed in Kingston. The designer will use the thermal design compliance option to meet energy efficiency requirements. The house will be heated with a gas-fired system. What is the minimum required thermal resistance value (RSI) of the foundation wall if the building permit application is submitted in 2008?

Solution:

→ Minimum thermal resistance values are set out in Table 12.3.3.3. when using the thermal design compliance option.

→ Since the building is heated with a forced air gas system, Column 4 in Table 12.3.3.3. is not applicable.

→ The RSI values for foundation wall associated with Zone 1 and Zone 2 are identical. Therefore there is no need to determine the heating degree-day zone for Kingston.

→ Therefore, the minimum RSI value for the foundation wall is 2.40 $m^2°C/W$.

COMPLETE THE NEXT EXERCISE

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EXERCISE 3A-3

The foundation wall for the building described in the example above is required to be insulated. To what depth must the insulation extend along the inside or outside surface of the foundation wall?

(a) At least 600 mm below the adjacent ground level

(b) To not more than 600 mm below the adjacent ground level

(c) To within 380 mm above the finished basement floor

(d) To more than 380 mm above the finished basement floor

_____

_____

_____

Code Ref.:_____

STOP

SLAB-ON-GROUND INSULATION

The minimum thermal resistance values set out in Table 12.3.3.3. "Minimum Thermal Resistance of Building Assemblies Based on Degree-Day Zones" are applicable to the insulation installed beneath the slab-on-ground.

The insulation applied to the exterior edge of the slab-on-ground is required to be at least 600 mm in length.

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Division B, Sentence 12.3.3.9.(5) provides two options for the installation of insulation along the exterior edge of the slab-on-ground:

- Extend down vertically at least 600 mm below the adjacent ground level

OR

- Extend down and outward from the floor or wall for a total distance of at least 600 mm measured from the adjacent ground level.

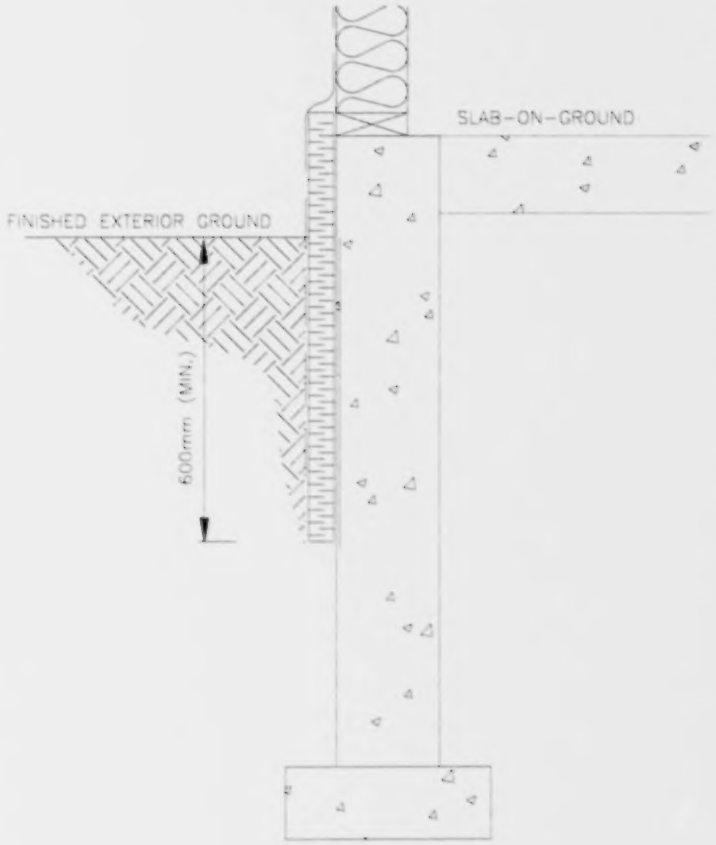

Figure 3A- 3 Thermal Insulation Installed Vertically for Slab-on-Ground

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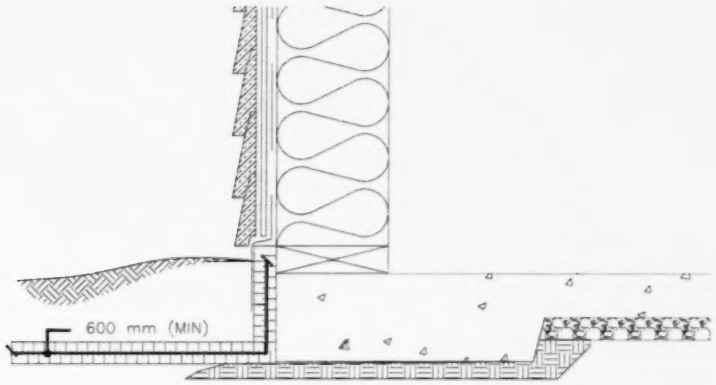
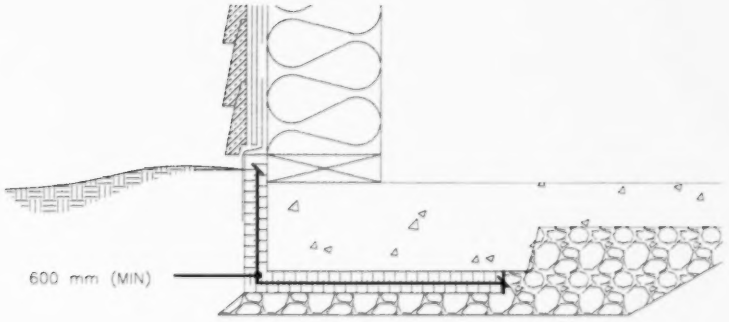


(a)



(b)

Figure 3A- 4 Two Configurations for Thermal Insulation Installed Down and Outward from the Floor or Wall

Note that the structural properties for the insulation should be considered.

STOP

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REDUCTION IN THERMAL RESISTANCE

The minimum thermal resistance values set out in Articles 12.3.3.3. and 12.3.3.4. for building assemblies are permitted to be reduced up to 20% under the following conditions:

As per Division B, Sentence 12.3.3.6.(1), the thermal resistance of a building assembly may be reduced by not more than 20 per cent ....

> *...where it can be shown that the total calculated* ***heat loss*** *from the building enclosure does not exceed the heat loss that would result* ***if*** *the enclosure were constructed in conformance with ...Articles 12.3.3.3. and 12.3.3.4.*

This Sentence allows engineered designs to be applied if the total calculated heat loss does not exceed the heat loss that would result if the enclosure were constructed by applying the referenced provisions. However, to apply this approach, the window area limits set out in Sentence 12.3.3.6.(1) must be met without any consideration for solar heat gain or orientation of the glazing. (See Module 3B)

Sentence 12.3.3.8.(1) also permits a reduction in the thermal resistance values set out in Table 12.3.3.3. to take into account the **thermal mass** of the building.

Thermal mass is a measure of the capability to store heat. Buildings with relatively high thermal mass will reduce and slow down the effects of sudden change in exterior temperature on the building's interior air temperature.

STOP

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EQUIPMENT EFFICIENCY

In addition to the thermal insulation compliance option requirements for energy efficiency, all Part 9 houses and residential buildings are required to meet minimum furnace efficiencies.

The minimum furnace fuel utilization efficiency requirements are set out in Article 12.3.1.2. The efficiency requirements are based on the fuel source of the furnace.

> Refer to Module 2A for an example on the application of Article 12.3.1.2.

END

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MODULE 3B

THERMAL DESIGN
WINDOWS AND DOORS

RESOURCE CONSERVATION HOUSE – 2006

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INTRODUCTION

This module describes how the thermal design option under Subsection 12.3.3. is used for the design of windows and doors to limit excessive energy consumption for houses. The factors influencing thermal performance of windows and doors using this option are explored and participants are given the opportunity to apply calculations to determine the amount of glazing permitted in houses using the thermal design option.

The thermal design compliance option used for windows and doors described in this Module and set out in Subsection 12.3.3. is required to be designed by an architect and/or by a professional engineer, as described in Division C, Sentence 1.2.1.1.(6).

OBJECTIVES

Upon completion of this module, participants will be able to:

- Recognize the application of CAN/CSA-A440.2
- Calculate the total area of glazing and apply glazing area limits
- Identify conditions for performance of windows and glazing
- Identify conditions for performance of doors
- Calculate the maximum window area
- Recognize the implications of shading
- Identify additional requirements for windows and doors for houses heated with electric space heating

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APPLICATION OF THE THERMAL DESIGN COMPLIANCE OPTION

Sentence 12.2.1.1.(3) sets out the minimum requirements for Part 9 houses and residential buildings relative to energy efficiency. **Three different compliance option**s are offered so that a designer can choose any option to meet the minimum energy efficiency requirements. As per Division B, Sentence 12.2.1.1.(3), Subsection 12.3.3. can be applied as one of the options.

A designer can apply the prescriptive thermal design requirements set out in Subsection 12.3.3. as one way of providing an energy efficient design if application for a building permit has been made before January 1, 2012.

All Part 9 houses and residential buildings and house permits submitted after December 31, 2011 will be required to meet the performance level that is greater or equal to a rating of 80 when evaluated in accordance to NRCan "EnerGuide for New Houses".

STOP

WINDOWS AND SLIDING DOORS THERMAL RESISTANCE REQUIREMENTS

Article 12.3.3.11. sets out the minimum energy performance of windows and other glazing for the thermal design option. Two options for window performance are provided, including:

- Application of Articles 12.3.2.6. and 12.3.2.8. (Part of the thermal insulation compliance option – Module 2B)

OR

- Application of Sentences 12.3.3.11.(2) and (3) (Part of the thermal design compliance option – Module 3B)

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If applying Articles 12.3.2.6 and 12.3.2.8 (as described further in Module 2B) for windows and sliding doors, glazing must meet one of the following:

- Maximum overall coefficient of heat transfer of 2.0 W/m^{o2}C

  OR

- Minimum energy rating of 17 (operable windows or sliding glass doors) and 27 (fixed windows)

Otherwise, Sentences 12.3.3.11.(2) and (3) provide an alternative approach to meeting performance provisions for glazing (as set out in Articles 12.3.2.6 and 12.3.2.8), by providing an option to apply a maximum area of glazing to separate heated space from an unheated space or the exterior.

TOTAL GLAZING AREA CALCULATION

The maximum area of glazing can be determined by applying the limitations set out in Sentence 12.3.3.11.(2).

The maximum area of glazing on a storey is required to satisfy both of the following criteria:

- Maximum 20% of the floor area of the storey,

  AND

- Maximum 40% of the area of the walls on the storey

When applying this calculation, remember:

- Include all glazing in windows, doors and skylights,

and

- For sloped walls, use the entire wall area projected onto a vertical plane (include opaque and non-opaque portions of sloped wall).

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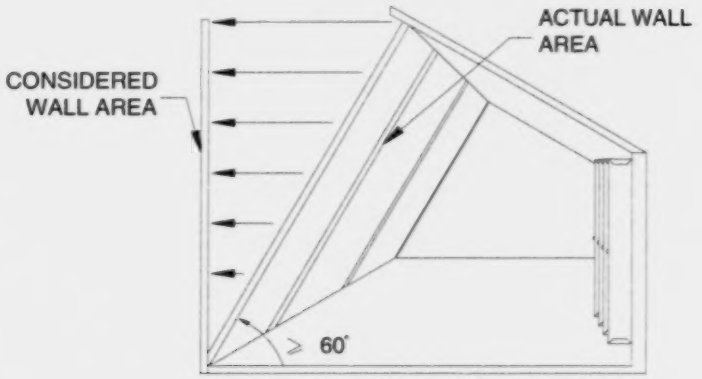

3B- 1 Projection of Sloped Wall with Glazing

A sloped wall is described in Sentence 9.10.1.2.(1) as having a slope of 60°or more to the horizontal. Where the slope of the assembly is at an angle less than 60°, the assembly is considered to be a roof.

As permitted by Sentences 12.3.3.11.(3) and (4), the actual glazing area may differ from the calculated maximum glazing area if:

- The thermal resistance of the actual glazing is different than that referenced by Articles 12.3.2.6.,12.3.2.8., and 12.3.3.10.

OR

- There are positive effects of winter solar gain and summer shading

The determination of winter solar gain and summer shading is explored later in this module.

By applying either of the above factors, the actual glazing has a different performance than that which was used to establish the area limits in Sentence 12.3.3.11.(2). When glazing has performance characteristics that exceed that prescribed by Articles 12.3.2.6. and 12.3.2.8., the effect is that larger glazing area is permitted since it has the same performance as a smaller glazed area that just meets the criteria.

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As was seen in Module 2B, thermal resistance of glazing is measured in terms of thermal conductance by assessing the performance of glazing in terms of coefficient of heat transfer and energy rating.

> Note: Refer to Module 2B to review thermal resistance, heat transfer coefficient and energy rating.

In addition to the area and performance requirements, basement windows that incorporate a load-bearing structural frame are required to be double glazed with low-E coating.

Different requirements apply where electric space heating is used. These are discussed later in the module.

Before proceeding to examine ways that the window area can be increased, the following example and exercises are provided to become familiar with the basic calculation procedures.

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EXAMPLE

Take a few minutes to read Sentence 12.3.3.11.(2)

A new house is being designed having the following dimensions: 10 m wide, 12 metres deep, and a storey height of 2.5 metres. Assume the glazing just meets thermal resistance requirements of 12.3.2.6, and ignore the effects of winter solar gain. Calculate the maximum glazing area permitted per storey when applying the thermal design compliance option.

Solution:

→ The floor area of a storey is
10 m x 12 m = 120 m^2

- 20% of 120 m^2 = 24 m^2 of glazing.

→ The total wall area of the storey is
(10 m + 10m +12 m + 12 m) x 2.5 m = 110 m^2

- 40% of 110 m^2 = 44 m^2 of glazing.

→ Since both criteria apply, the lower of the two glazing area calculations is the maximum glazing area that is permitted.

→ Therefore, the maximum glazing area permitted is 24 m^2.

STOP

COMPLETE THE FOLLOWING TWO EXERCISES

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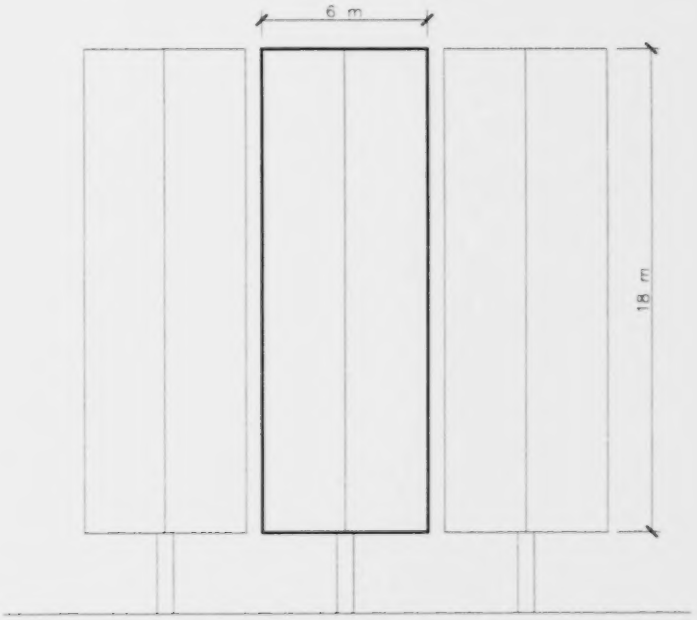
EXERCISE 3B-1

A developer is planning to build a 2 storey townhouse on an infill lot. Due to site constraints, glazing is not permitted in the side walls, so the developer wants to maximize the glazing on the front and rear walls of the first storey. The house will be 6 metres wide, 18 metres deep, and each storey is 3 metres high.



PLAN VIEW

ELEVATION PLAN

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What is the total permitted area of glazing for each storey?

(a) 50.4 m^2

(b) 18 m^2

(c) 57.6 m^2

(d) 21.6 m^2

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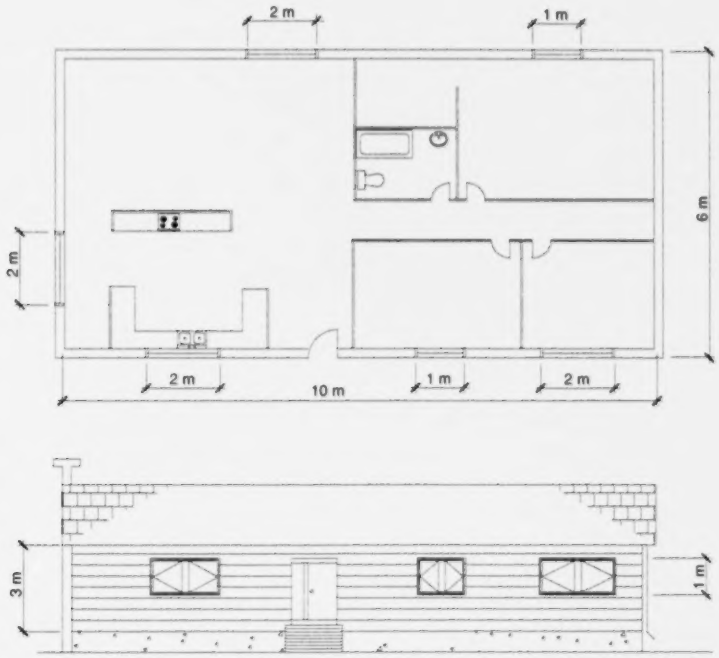
EXERCISE 3B-2

The plans for the first storey of a house (6 m by 10 m) are showing glazing as described in the figure below. All windows are 1 m high and the door does not have any glazing.



Calculate the maximum permitted glazing area and assess whether the proposed glazing meets the conditions of Sentence 12.3.3.11.(2).

STOP

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RATIO OF ACTUAL VERSUS REQUIRED THERMAL RESISTANCE OF WINDOWS AND DOORS

As noted earlier, Sentence 12.3.3.11.(3) allows glazing with different performance characteristics (than those prescribed by Article 12.3.2.6 and 12.3.2.8) to be compared to the performance that would be achieved if compliant with the prescribed characteristics, and the area of the proposed glazing is permitted to be adjusted to account for those differences.

Before assessing the ratio of the difference between actual and minimum performance requirements, the performance characteristics from Articles 12.3.2.6. and 12.3.3.8. are revisited. These are the same criteria that were reviewed in Module 2B.

The two criteria are coefficient of heat transfer and energy rating.

The coefficient of heat transfer ($W/m^2°C$) is a measure of the thermal properties of the material. The coefficient of heat transfer is the inverse of the thermal resistance value (RSI).

$$\text{Coefficient of Heat Transfer} = \frac{1}{RSI}$$

The energy rating (W/m^2) is a separate measure of energy performance of a window that accounts for other factors, such as solar gains and thermal losses. Both the coefficient of heat transfer and the energy rating can be obtained from the window manufacturer.

The ratio that is applied to the proposed glazing area in order to compare to the maximum permitted area from Sentence 12.3.3.11.(2) is called the **glazing factor**. The glazing factor is the ratio of the required versus the actual thermal resistance of the glazing. The actual proposed glazing area can be adjusted by the glazing factor to determine the effective area, as follows:

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Effective Area = Glazing Factor X Actual Area

Where:

- Effective area: Area to be compared to maximum permitted area
- Actual area: Area of proposed glazing

$$\text{Glazing factor} = \frac{\text{RSI value (required)}}{\text{RSI value (actual)}} \quad \text{(Eqn. 1)}$$

However, glazing properties are usually provided as **coefficient of heat transfer** ($m^2°C/W$), which is the inverse of thermal resistance (RSI value). As such, the glazing factor should be applied as follows:

$$\text{Glazing factor} = \frac{\frac{1}{\text{coefficient of heat transfer (required)}}}{\frac{1}{\text{coefficient of heat transfer (actual)}}} \quad \text{(Eqn. 2.1)}$$

OR

$$\text{Glazing factor} = \frac{\text{coefficient of heat transfer (actual)}}{\text{coefficient of heat transfer (required)}} \quad \text{(Eqn. 2.2)}$$

As an alternative solution, using the Objective-Based Code when glazing properties are provided in terms of **energy rating**, the glazing factor may also be calculated as follows:

$$\text{Glazing factor} = \frac{\text{energy rating (required)}}{\text{energy rating (actual)}} \quad \text{(Eqn. 3)}$$

As seen before, glazing can meet one of two conditions from Article 12.3.2.6.:

- Maximum overall coefficient of heat transfer of 2.0 $W/m^2° C$,

  OR

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- Minimum energy rating of 17 (operable windows or sliding glass doors) and 27 (fixed windows).

Different criteria apply to sliding doors or windows where electric space heating is used in a dwelling unit as per Article 12.3.2.8.

EXAMPLE

A window has a coefficient of heat transfer of 1.0 W/m^2C.

(a) What is the ratio that is used to determine the effective glazing area?

(b) Will a coefficient of heat transfer of 1.0 W/m^2C permit more or less glazing than that calculated from Sentence 12.3.3.11.(2)?

Solution:

(a) To calculate the ratio, the actual coefficient of heat transfer is divided by the required coefficient of heat transfer (Eqn 2.2), as provided in Sentence 12.3.3.11.(3)

→ Glazing factor=$\frac{\text{coefficient of heat transfer (actual)}}{\text{coefficient of heat transfer(required)}}$

→ Glazing factor = 1.0 ÷ 2.0 = 0.5

(b) A window with a lower coefficient of heat transfer will perform better than one with a higher coefficient of heat transfer. The glazing factor of 0.5 has the effect of reducing the negative impacts and the effective area of a window that will be compared to the maximum permitted window area.

→ Therefore, a larger glazing area is permitted than that calculated from Sentence 12.3.3.11.(2).

STOP

COMPLETE THE NEXT EXERCISE

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EXERCISE 3B-3

It was determined that the total permitted fixed glazing area for a 1 storey building was 18 m^2. The designer would like to have a total fixed glazing area of 30 m^2. What minimum energy rating must be specified such that the performance level of the fixed glazing will be equivalent to a total fixed glazing area of 18 m^2.

(a) Energy rating of 27

(b) Energy rating of 45

(c) Energy rating of 17

(d) Energy rating of 16.2

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IMPLICATIONS OF SHADING

As seen previously, Sentence 12.3.3.11.(3) allows for an increase in glazing area if the actual thermal resistance of the proposed glazing is greater than that referenced by Articles 12.3.2.6 and 12.3.2.8.

In addition to Sentence 12.3.3.11.(3), the glazing area calculation can also be modified to consider the positive effects of winter solar heat gain.

This calculation is set out in Sentence 12.3.3.11.(4). The following conditions must be met in order to apply the positive effects of winter solar heat gain:

- Glazing must be clear glass, or have a shading coefficient of more than 0.70.
- Glazing must be unshaded in winter (shading calculated using the noon sun angles of December 21).
- Glazing must face within 45 degrees of due south.
- The house must have a system that is capable of distributing the solar heat gain throughout the building, such as a forced air heating system.
- If the building has a cooling system, the glazing must be shaded in the summer with exterior devices (shading calculated using the noon sun angles of June 21).

The area of glazing that meets the above criteria is permitted to be considered as 50% of the unshaded area. In other words, this glazing would count as only half of its actual area when calculating the overall glazing on the storey to confirm that the overall glazing area meets the limits of Article 12.3.3.11.

Factors contributing to noon sun angles include latitude and tilt of the earth, which is fixed on December 21st and June 21st for all locations.

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NOON SUN ANGLES

On June 21, the northern hemisphere of the earth is tilted 23.5° towards the sun. Whereas on December 21, the northern hemisphere of the earth is tilted 23.5° away from the sun.

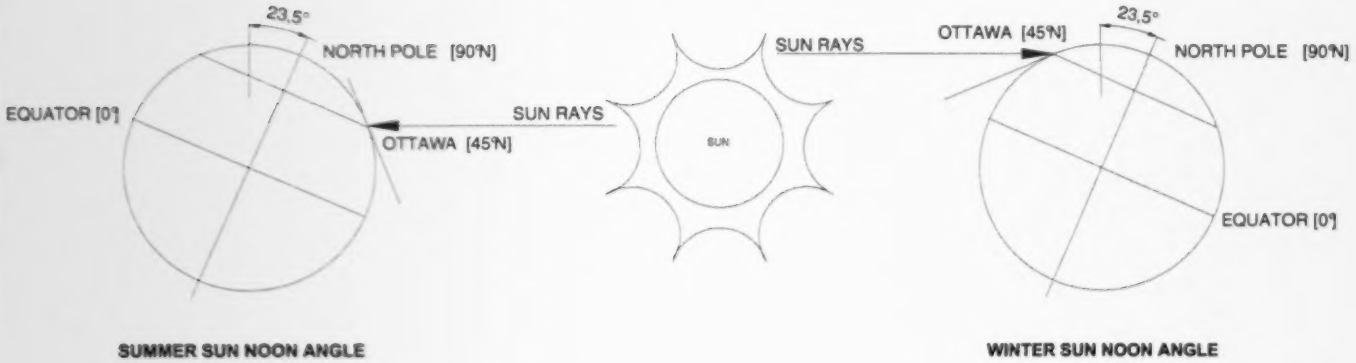

Figure 3- 1 Schematic of Noon Sun Angles (Example provided for Ottawa)

To calculate the noon sun angle in Ontario, the following formula can be applied:

Noon sun angle = 90° – (Latitude of Location - D)

Where:

D= - 23.5° on December 21st (Winter)

D = + 23.5° on June 21st (Summer)

EXAMPLE

A new 1 storey house will be constructed in Ottawa (located at a latitude of 45° N). The house will have clear glazing and will be cooled during summer months. Determine the noon sun angles for December 21st (winter) and June 21st (summer).

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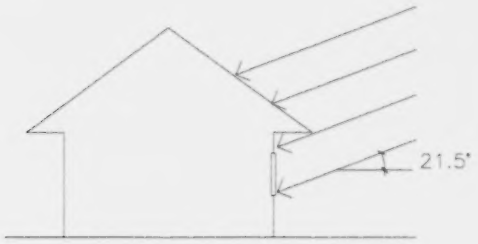
Solution:

→ On December 21st (winter)

Noon sun angle = 90° – (45°N – (- 23.5°S)= 21.5°

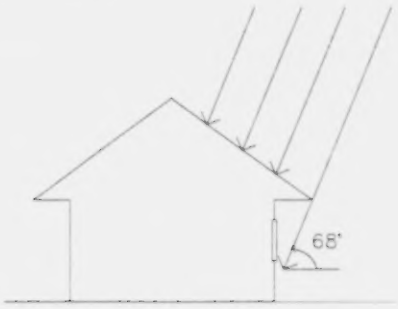


WINTER NOON SUN
ANGLE FOR OTTAWA

If the windows will be unshaded when the sun is at 21.5° above the horizon (noon sun angle on December 21st), then the surface is considered to be unshaded and the solar heat can be counted.

→ On June 21st (summer)

Noon sun angle = 90° – (45°N – 23.5°S) = 68°



SUMMER NOON SUN
ANGLE FOR OTTAWA

South facing windows in an air conditioned building must be shaded to be protected from the sun when it is at an angle of 68° above the horizon (June 21st)

STOP

COMPLETE THE NEXT FOUR EXERCISES

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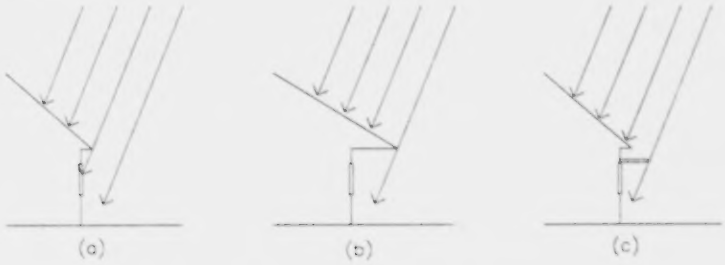
EXERCISE 3B-4

The figures below represent a section view of the south elevation of a 1 storey house showing the sun at the summer noon sun angle. The house will be cooled during summer months, and windows are unshaded in the winter. There will be a forced air system capable of distributing the solar heat gain throughout the building.

Which of the following solar shading designs will permit the area of glazing on the south elevation to be 50% of its area when calculating the maximum glazing area?



(a) All of designs (a), (b) or (c)

(b) Either design (a) or (c)

(c) Either design (a) or (b)

(d) Either design (b) or (c)

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EXERCISE 3B-5

A new 1 storey house in Ottawa will have a forced air heating system, and will not be cooled during the summer.

The house is 10 m wide, 20 m deep, and 3 metres high. The south wall will have a total glazing area of 50 m^2. The windows are not shaded in winter. Is this glazing area permitted if the glazing has a shading coefficient of 0.71?

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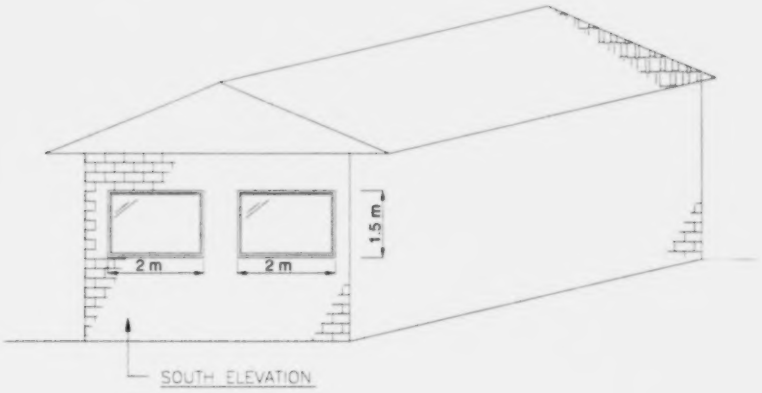
EXERCISE 3B-6

A new house has two large south-facing windows with clear glazing of 2 m long by 1.0 m high that are unshaded in winter and has a system capable of distributing the solar heat gain throughout the building. The house is not air-conditioned. What area of glazing do these windows contribute to the total area of glazing?



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EXERCISE 3B-7

An air-conditioning system will be installed in the same house in the exercise above. What exterior building features need to be provided so that the total glazing area can be decreased to apply the credit for solar heat gain?

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STOP

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THERMAL RESISTANCE REQUIREMENTS FOR DOORS

Table 12.3.3.3. "Minimum Thermal Resistance of Building Assemblies Based on Degree-Day Zones" does not include minimum thermal resistance values for doors.

Sentence 12.3.3.12.(3) references Article 12.3.2.7. and 12.3.2.8. to determine the minimum thermal performance requirements for doors that separate a heated space from an unheated space. Articles 12.3.2.7. and 12.3.2.8. are also applicable to the thermal insulation compliance option described Module 2B.

As seen in Module 2B, Sentence 12.3.2.7.(1) is applicable to all doors that separate heated space from the outside, except doors on enclosed unheated vestibules and cold cellars or where storm doors are provided. As per Sentence 12.3.2.7.(1), the non-glazed portion of doors are required to have a minimum thermal resistance of not less than RSI 0.7.

In addition to the minimum thermal performance requirements, the thermal design compliance option has minimum infiltration rates for doors that are described in the following Section in this module.

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IMPACT OF ELECTRIC SPACE HEATING

The requirements for thermal resistance of windows and sliding doors are more stringent where electric space heating is used in houses.

Sentence 12.3.2.8.(2) sets the minimum requirements for windows that separate unheated spaces (or the outdoors) from spaces with electric space heating is used. Windows and glazing must meet one of the following:

- Maximum overall coefficient of heat transfer: 1.6 W/m2°C,

  OR

- Minimum energy rating of 25 (operable windows or sliding glass doors) and 35 (fixed windows).

Sentence 12.3.2.8.(1) sets the minimum requirements for sliding doors where electric heating is used. Sliding glass doors must meet one of the following:

- Maximum overall coefficient of heat transfer: 1.6 W/m2°C,

  OR

- Minimum energy rating of 25.

STOP

COMPLETE THE NEXT TWO EXCERCISES

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EXERCISE 3B-8

A new house is being designed with electric space heating. What is the maximum overall coefficient of heat transfer for sliding doors separating an exterior patio from the interior of a house?

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Code Ref.:_____

EXERCISE 3B-9

A new 3 storey townhouse, having a footprint area of 500 m^2, is being designed with electric space heating. What is the minimum energy rating for operable windows forming part of an exterior wall in each of the individual units?

(a) 25

(b) 35

(c) 17

(d) 27

Code Ref.:_____

END

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MODULE 3C

AIR INFILTRATION

RESOURCE CONSERVATION HOUSE – 2006

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Application of Air Barrier Requirements 7

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INTRODUCTION

This module focuses on how air infiltration can be controlled to limit energy consumption in Part 9 houses and residential occupancies.

The minimum provisions discussed in this module are required to be satisfied when applying the thermal design compliance option under Subsection 12.3.3.

OBJECTIVES

Upon completion of this module, participants will:

- Calculate maximum air infiltration rates for windows, sliding glass doors, and doors
- Recognize the Part 9 requirements that are still applicable for vapour barrier protection
- Apply provisions for caulking and sealing at sill plates and foundations
- Recognize the requirements for air barriers around service penetrations from roof or attic spaces

READ TO THE NEXT STOP

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AIR INFILTRATION

Air infiltration is the ingress of air through building assemblies acting as environmental separators through cracks or other openings around windows or doors.

One way air is forced through these openings is by pressure differences caused by wind or due to stack effect.

As per Division A, Table 3.2.1.1. "Functional Statements", and Table 12 of SA-1 "Objectives and Functional Statements Attributed to the Acceptable Solutions in Part 12 of Division B", the functional statements associated with the requirements for air infiltration around windows, doors, and sliding doors are:

- *"To limit drafts" [Functional Statement F54]; and*
- *"To resist the transfer of air through environmental separators" [Functional Statement F55]*

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AIR INFILTRATION REQUIREMENTS

Maximum air infiltration rates for windows, doors, and sliding glass doors are set out in Division B, Sentences 12.3.3.13.(1) to 12.3.3.13.(4).

The following are the maximum permitted air infiltration rates for assemblies separating heated spaces from unheated spaces:

Maximum Air Infiltration Rates Forming Part of Sentences 12.3.3.13.(1) to (4)

Assembly	Maximum air infiltration rates
Windows	0.775 L/s per metre of sash crack
Manual operating exterior sliding glass doors	2.5 L/s per m^2 of door area
Exterior swing type doors for dwelling units and hotel rooms	6.35 L/s per m^2 of door area
All other doors	17.0 L/s per metre of sash crack

The air infiltration rates for windows, doors, and sliding doors are determined when they are tested at a pressure differential of 75 Pa using the ASTM E283 Standard "Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen".

The air infiltration rates determined using ASTM E283 (usually available from the door or window manufacturer) must not be greater than the above-specified rates.

STOP

COMPLETE THE NEXT EXERCISE

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EXERCISE 3C-1

A window opening for a house is 1.5 m high by 0.5 m wide. A casement (swing out) operable window is being considered for this opening, such that the operable portion of the window will make up the entire window opening. A casement window manufacturer provides evidence that their window has an air leakage rate of 3.0 L/s for this size of window, when tested in accordance with ASTM E283. Does this proposed window meet the requirement of 12.3.3.13?

STOP

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EXCEPTIONS TO AIR INFILTRATION REQUIREMENTS

The maximum air infiltration rates set out in Sentences 12.3.3.13.(1) to 12.3.3.13.(4) do not apply to the following doors:

- *"Doors used primarily to facilitate the movement of vehicles or handling of material..."* [Sentence 12.3.3.12.(2)] such as overhead garage doors for houses
- *"Doors on enclosed unheated vestibules..."* [Sentence 12.3.3.12.(3)] such as doors to unheated porches
- Exterior swing type doors *"that are weather-stripped on all edges and protected with a storm door..."* [Sentence 12.3.3.13.(3)]
- Exterior swing type doors *" that are weather-stripped on all edges and ...protected by an enclosed unheated space..."*[Sentence 12.3.3.13.(3)]

Doors that are described above are not required to meet any maximum air infiltration rate and are not required to be tested in accordance with ASTM E283.

STOP

COMPLETE THE NEXT EXERCISE

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EXERCISE 3C-2

What are the maximum air infiltration rates for the following building assemblies when applying the thermal design compliance option to a Part 9 house? Indicate the units of measurement for the air infiltration rates.

Building Assembly	Air Infiltration Rate	Code Ref.
Sliding glass door (manually operated) separating a kitchen from the exterior		
Operable windows installed in exterior walls		
Building entrance door separating the interior space from the exterior.		
Exterior door that separates an enclosed storage garage and the building.		
Junction between the sill plate of a door and the foundation wall		

STOP

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CAULKING MATERIAL REQUIREMENTS

Where caulking is applied to limit the infiltration of air from the exterior to the interior of a Part 9 house or residential building, the material used as caulking is required to meet the minimum requirements set out in Subsection 9.27.4., as referenced by Sentence 12.3.3.13.(5).

Article 9.27.4.2. requires that caulking materials have the following characteristics:

- non-hardening type suitable for exterior use
- resist the effects of weathering

AND

- compatible and adhere to the substrate to which it is applied

Additionally, caulking materials must meet the requirements of specific CGSB and CAN/CGSB standards, as set out in Sentence 9.27.4.2.(2)

APPLICATION OF AIR BARRIER REQUIREMENTS

The air barrier system for a house must be installed per Subsection 9.25.3, as referenced by Sentence 12.3.3.13(7).

An air barrier resists the transfer of air through a building assembly.

An air barrier system is required in a Part 9 house or residential building where service penetrations pass through an assembly separating a heated space from a roof or attic space.

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Airtight elements may include:

- Gypsum board sealed by caulking, gaskets, tape, etc.

OR

- Continuous air barrier system (e.g. sheet of polyethylene)

The air barrier system must be installed per Subsection 9.25.3, as referenced by Sentence 12.3.3.13(7).

Openings through the air barrier such as for electrical boxes, electrical wiring, or plumbing installations provide opportunities for air leakage into concealed spaces. These openings must be as airtight as possible.

END

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MODULE 4

NRCAN ENERGUIDE COMPLIANCE OPTION

RESOURCE CONSERVATION HOUSE – 2006

Airtight elements may include:

- Gypsum board sealed by caulking, gaskets, tape, etc.

OR

- Continuous air barrier system (e.g. sheet of polyethylene)

The air barrier system must be installed per Subsection 9.25.3, as referenced by Sentence 12.3.3.13(7).

Openings through the air barrier such as for electrical boxes, electrical wiring, or plumbing installations provide opportunities for air leakage into concealed spaces. These openings must be as airtight as possible.

END

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MODULE 4

NRCAN ENERGUIDE COMPLIANCE OPTION

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Equipment efficiency for Part 9 Residential Buildings 7

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INTRODUCTION

This module describes how NRCan "EnerGuide for New Houses: Administrative and Technical Procedures" may be used as an option to meet the minimum performance requirements for energy efficiency in Part 9 houses and residential buildings up to December 31, 2011 and will be used as the measure for energy efficiency of these buildings after December 31, 2011.

OBJECTIVES

Upon completion of this module, participants will be able to:

- Recognize the rating system for NRCan "EnerGuide for New Houses"
- Identify the factors that influence the performance level of "EnerGuide for New Houses" rating

READ TO THE NEXT STOP.

APPLICATION OF NRCAN ENERGUIDE TO PART 9 RESIDENTIAL BUILDINGS UP TO DECEMBER 31, 2011

Sentence 12.2.1.1.(3) sets out the minimum requirements for Part 9 houses and residential buildings relative to energy efficiency. Three different compliance options are offered so that a designer can choose any option to meet the minimum energy efficiency requirements. As per Division B, Sentence 12.2.1.1.(3), any one of clauses (a), (b), or (c) can be applied:

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Division B, Sentence 12.2.1.1.(3)

The energy efficiency of a building or part of a building of residential occupancy that is within the scope of Part 9 and is intended for occupancy on a continuing basis during the winter months shall,

(a) Conform to the thermal insulation requirements of Subsection 12.3.2.

(b) Conform to the thermal design requirements of Subsection 12.3.3.

OR

(c) Provide a rating of 80 or more when evaluated in accordance with NRCan 'EnerGuide for New Houses: Administrative and Technical Procedures'

If a building permit application has been made up to December 31, 2011, one way a designer can meet the minimum energy efficiency requirements is by demonstrating that the house has a performance level greater than or equal to a rating of 80 when evaluated in accordance with NRCan "EnerGuide for New Houses: Administrative and Technical Procedures".

All applications for house permits submitted after December 31, 2011 will be required to demonstrate that they have the performance level that would be achieved by a rating of 80 using NRCan "EnerGuide for New Houses".

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ENERGY EFFICIENT DESIGN FOR PART 9 RESIDENTIAL BUILDINGS AFTER DECEMBER 31, 2011

After December 31, 2011, new residential buildings within the scope of Part 9 houses and residential buildings must meet the performance level that is representative of a rating of 80 or more when evaluated in accordance with the NRCan "EnerGuide for New Houses: Administrative and technical Procedures". A building with a label indicating a rating of 80 or more will demonstrate this requirement, however, it is not necessary to obtain a label in order to demonstrate equal performance.

A technical evaluation will be required to be undertaken by a knowledgeable person to compare the performance of a design for a Part 9 house or residential building against the criteria and relative performance that would be demonstrated by the EnerGuide label.

NRCAN ENERGUIDE RATING SYSTEM

The NRCan "EnerGuide for New Houses" rating is a guide used to evaluate the energy efficiency of a building.

If applying the NRCan "EnerGuide for New Houses" labeling system to meet the minimum requirements for energy efficiency of new houses, the new building having a rating of 80 shall be deemed to be in compliance with the Building Code.

When applying the NRCan "EnerGuide for New Houses", the rating system of a house is evaluated on a logarithmic scale from 0 to100, where:

- A rating of 0 represents major air leakage, no insulation, and extremely high energy consumption.

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- A rating of 100 represents a building that is air tight, well insulated and sufficiently ventilated that requires no net purchased energy, and is completely energy self-sufficient (e.g. uses solar, wind or other renewable energy sources).

The following table outlines typical rating ranges:

EnerGuide Rating Chart	
Type of Building	**Rating**
Typical modern house	66 to 74
Energy-efficient modern building (e.g. A 2006 Building Code compliant house, up to December 31, 2011)	75 to 79
Highly energy-efficient modern house	80 to 90
An "advanced house" that uses little or no purchased energy	91 to 100

STOP

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EXERCISE 4-1

A design for a 150 m^2, 3 storey house is currently being undertaken. The building permit application will be submitted in 2008. The design will achieve a performance level equal to a rating of 80 if it was evaluated in accordance to NRCan "EnerGuide for New Houses: Administrative and Technical Procedures"

Will the building meet the minimum energy efficiency design requirements?

_____

_____

_____

_____

Code Ref.: _____

STOP

FACTORS INFLUENCING THE OVERALL ENERGY EFFICIENCY WHEN EVALUATED IN ACCORDANCE WITH ENERGUIDE

An NRCan EnerGuide rating and label for a new house is dependent on building characteristics and on an energy simulation. Building characteristics which affect the overall energy efficiency of the building include:

- Direction and angle the building faces (e.g. south, north etc.)
- Insulation levels
- Heating and ventilation equipment (e.g. furnace)
- Building envelope (e.g. windows and doors)

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Note that the energy simulation that is part of the NRCan EnerGuide labeling process does not consider the occupants' energy-using habits and efficiency of general appliances. Also, the modeling software makes some assumptions when determining the EnerGuide rating. Assumptions include:

- Number of occupants (4 occupants)
- Thermostat setting (21°C main floors, 19°C for basements)
- Hot water consumption (225 litres/day)
- Lighting and appliance electricity consumption (24 kW/day)
- Monthly average ventilation rate (0.35 air change/hour during the heating season)

The energy simulation is an estimation of the combined energy use of various features in a house, such as:

- Heating
- ventilation
- hot water
- lighting fixtures or equipment.

The simulation results for the house represent the performance of the building as a complete system. Accordingly, the relatively poor performance of one particular element can be offset by an exceptional performance of other elements.

STOP

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EQUIPMENT EFFICIENCY FOR PART 9 RESIDENTIAL BUILDINGS

In addition to the NRCan EnerGuide compliance option for energy efficiency, all Part 9 houses and residential buildings are required to meet minimum furnace efficiencies.

The minimum furnace fuel utilization efficiency requirements are set out in Article 12.3.1.2. The efficiency requirements are based on the fuel source of the furnace.

> Refer to Module 2A for an example on the application of Article 12.3.1.2.

END

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MODULE 5

MOTION SENSORS

RESOURCE CONSERVATION HOUSE – 2006

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INTRODUCTION

This module focuses on how motion sensors can contribute to an energy efficient design for Part 9 residential buildings and houses. The limitations on their use are also described.

OBJECTIVES

Upon completion of this module, participants will be able to:

- Identify limitations for use of motion sensors to control lighting
- Recognize the features for controls of motion sensors

READ TO THE NEXT STOP.

APPLICATION

As per Article 12.2.2.1. motion sensors are permitted to be used to control lighting in Part 9 residential buildings and houses, with certain limitations (addressed below).

LIMITATIONS

Although motion sensors contribute to energy conservation, motion sensors **are not permitted** to control minimum lighting levels in **exits** in Part 9 residential buildings or houses.

Motion sensors are permitted in an exit but only if the motion sensors control **supplementary** lighting that is provided over and above the minimum lighting levels set out in Article 9.9.11.2. (egress facilities), and Article 9.34.2.7. (public and service areas).

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In addition to exits where motion sensors are not permitted, motion sensors are **not permitted to control emergency lighting**, as per Sentence 12.2.2.1.(3). Requirements for emergency lighting are described elsewhere in the Code, including Division B, Article 9.9.11.3.

STOP

CONTROLS

Additional features are required for motion sensors installed in specific locations, as set out in Sentence 12.2.2.1.(2).

Division B, Sentence 12.2.2.1.(2)

> *Where motion sensors are used to control minimum lighting in a public corridor or corridor proving access to exit for the public...*

In these locations, the motion sensor must have the following additional features, as per Sentence 12.2.2.1.(2):

- Switch controllers equipped for fail-safe operation that will override the motion sensor in the event that the sensor mal function does not detect movement.

AND

- Illumination timers must be set for a minimum of 15 minutes duration.

These features apply only to public corridors or a corridor providing access to exit for the public.

Division A, Article 1.4.1.2. defines a **public corridor** as *"...a corridor that provides access to exit from more than one suite".*

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Therefore, corridors providing access to exit for the public or corridors that serve more than one suite are required to meet Sentence 12.2.2.1.(2).

As described by Functional Statements F10 and F30, which are attributed to these provisions as per Table 12 of SA-1, these control features are to provide minimum illumination levels to facilitate the timely movement of occupants to a safe place in an evacuation and to minimize the risk of injuries as a result of tripping, slipping, etc.

EXAMPLE

The design of a new 2 storey house having a footprint area of 200 m^2 proposes the use of motion sensors for the normal lighting in the basement.

Are the minimum illumination levels for the basement permitted to be controlled with motions sensors?

Solution:

→ Sentence 12.2.2.1.(1) generally permits the use of motion sensors in these areas.

→ Emergency lighting is not permitted to be controlled by motion sensors.

→ However, emergency lighting is not required in a basement in a house.

Therefore:

→ The basement is permitted to make use of motion sensors to control the minimum lighting levels, as otherwise required by Division B, Table 9.34.2.7.

STOP

COMPLETE THE NEXT EXERCISE

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EXERCISE 5-1

For each of the areas listed below identify whether motion sensors are permitted to control minimum illumination levels (unless indicated otherwise).

Area	Permitted	Not Permitted	Code Reference
Example: Public corridor serving multiple residential suites	✓		Sentence 12.2.2.1.(2)
Entrance vestibule in a dwelling unit			
Bedroom in a dwelling unit			
Exit stairwell in a multi-unit residential building			

END

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MODULE 6

WATER EFFICIENCY

RESOURCE CONSERVATION HOUSE – 2006

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Maximum Flush Cycles for Sanitary Fixtures that Replace Existing Fixtures 5
Exceptions to Water Efficiency Requirements 7
Summary of Requirements 8

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INTRODUCTION

This module focuses on how maximum flow rates of water supply fittings and flush cycles for plumbing fixtures contribute to water conservation in all buildings including houses.

OBJECTIVES

Upon completion of this module, participants will be able to:

- Apply the requirements of Subsection 7.6.4., as cross-referenced in Part 12.
- Identify the maximum flow rates for water fixtures
- Identify the maximum flush cycles for new sanitary plumbing fixtures
- Identify the maximum flush cycles for sanitary fixtures that replace existing fixtures

READ TO THE NEXT STOP

APPLICATION OF WATER EFFICIENCY

Sentence 12.4.1.1(1) references Subsection 7.6.4. for water efficiency and the requirements for new water supply fittings and plumbing fixtures in all buildings including houses:

Division B, Sentence 12.4.1.1.(1)

> *All buildings shall conform to the water efficiency requirements of Subsection 7.6.4.*

The water efficiency requirements in Subsection 7.6.4 support the objective OR1 "Resource Conservation – Water Conservation". Water efficiency requirements apply to water supply fittings and plumbing fixtures.

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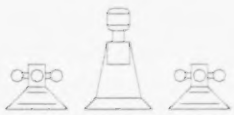
Where new fixtures are being installed as a result of **renovations**, separate requirements in Subsection 7.6.4. apply to these sanitary fixtures that will be installed as a replacement of existing fixtures in a building that was constructed prior to January 1996. The provisions set out in Subsection 7.6.4. apply as referenced by Part 11 "Renovation".

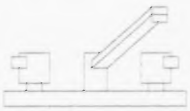
MAXIMUM FLOW RATES FOR WATER SUPPLY FITTINGS

Table 7.6.4.1. "Maximum Flow Rates for Water Supply Fittings" sets out the maximum flow rates (Litres/minute) at specific test pressures (kPa) for the following fixtures in buildings:

Lavatory faucets



Kitchen faucets



Shower heads

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Manufacturers typically provide the flow rating of fixtures at specific test pressures.

The flow rating of **each fixture** must be less or equal to the flow rates set out in Table 7.6.4.1. "Maximum Flow Rates for Water Supply Fittings".

However, where a single person shower stall or facility is provided with **more than one** shower head, the combined flow rate of all fixtures in that shower stall or facility must meet the maximum flow rates set out in Table 7.6.4.1.

EXAMPLE

What is the maximum flow rate for a faucet installed in a kitchen?

Solution:

→ Refer to Table 7.6.4.1. "Maximum flow rates for Water Supply Fixtures"

- Kitchen faucets: less than 8.35 L/min (tested at 413 kPa)

STOP

COMPLETE THE NEXT EXERCISE

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EXERCISE 6-1

A new home will have showers in two separate bathrooms. Each shower will have a single shower head. The shower heads were each tested at 550 kPa for 5 minutes. The total flow out of each fitting was 45 Litres. Are these shower heads permitted to be installed in the new home?

(a) Yes. Flow rate is less than the maximum permitted flow rate

(b) No. Flow rate cannot be determined

(c) No. Flow rate is greater than the maximum permitted flow rate

(d) No. Flow was tested at a different pressure

_____

_____

_____

Code Ref.: _____

STOP

MAXIMUM FLUSH CYCLES FOR SANITARY FIXTURES

As per Division B, Sentence 7.6.4.2.(1), new water closets and urinals in all houses (subject to exception for replacement fixtures – see below) are required to be:

...certified to CAN/CSA-B45.0 'General Requirements for Plumbing Fixtures'

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In addition to the requirements of CAN/CSA-B45.0, Table 7.6.4.2.B "Maximum Flush Cycles for Sanitary Fixtures" lists the maximum flush cycles for the following sanitary fixtures:

- Water closet (tank type)
- Water closet (direct flush)
- Urinal (tank type)
- Urinal (direct flush)

A flush cycle is a volume of water [Litres] used to complete one full flush for sanitary fixtures (urinals and water closets).

MAXIMUM FLUSH CYCLES FOR SANITARY FIXTURES THAT REPLACE EXISTING FIXTURES

Flush cycles for **replacement** sanitary fixtures are permitted to be higher than flush cycles for sanitary fixtures installed in new buildings.

Table 7.6.4.2.A. "Maximum Flush Cycles for Sanitary Fixtures" sets out the maximum flush cycles for water closets and urinals installed to replace existing fixtures in a building that was constructed prior to January 1, 1996.

If the new sanitary fixture replaces another *fixture* that was installed after January 1, 1996 in a building constructed before January 1, 1996, the higher flush cycle is still permitted.

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EXAMPLE

How much water is permitted to be used for a flush cycle for a toilet (with a tank) in a new townhouse?

Solution:

→ The building is new, therefore Table 7.6.4.2.B. "Maximum Flush Cycles for Sanitary Fixtures" is applicable.

→ The toilet is a tank type.

→ The maximum flush cycle is 6 Litres.

Code Ref.: _____

STOP

COMPLETE THE NEXT TWO EXERCISES

EXERCISE 6-2

What is the maximum flush cycle for a urinal (tank type) that will be installed in a new home?

(a) 5.68 Litres

(b) 3.8 Litres

(c) 6 Litres

(d) 13.25 Litres

_____

_____

Code Ref.: _____

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EXERCISE 6-3

What is the maximum flush cycle for a water closet that will be replacing an existing toilet that was installed in 1998 in a small house that was constructed in 1985?

(a) 5.68 Litres

(b) 3.8 Litres

(c) 6 Litres

(d) 13.25 Litres

_____

_____

Code Ref.: _____

STOP

EXCEPTIONS TO WATER EFFICIENCY REQUIREMENTS

New faucets, shower heads, water closets, and urinals installed in ***heritage buildings*** do **not** need to meet the requirements for maximum flow rates [Table 7.6.4.1.] nor the maximum flush cycles [Tables 7.6.4.2.A and 7.6.4.2.B].

Division A, Article 1.4.1.2. defines a heritage building as a building that is:

(c) ...designated under the Ontario Heritage Act,

OR

(b) ... certified to be of significant architectural or historical value by a recognized, non-profit public organization whose primary object is the preservation of structures of architectural or historical significance and the certification has been accepted by the chief building official.

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However, the maximum flow rates established by Table 7.6.4.1. "Maximum Flow Rates for Water Supply Fittings" are applicable to the above locations.

SUMMARY OF REQUIREMENTS

The following table summarizes the maximum flow rates for water supply fittings as well as the maximum flush cycles for sanitary fixtures.

Fixture	Maximum Flow Rates (L/min) and Flush Cycle (L) (In buildings existing before January 1, 1996)	Maximum Flow Rates (L/min) and Flush Cycle (L) (In new buildings as well as in buildings existing after January 1, 1996)
Lavatory Faucets	8.35 L/min	
Kitchen Faucets	8.35 L/min	
Shower Heads	9.5 L/min	
Water Closets	13.25 L	6 L
Urinals	5.68 L	3.8 L

END

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ANSWER GUIDE

RESOURCE CONSERVATION HOUSE – 2006

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<table>
<tr><th>Exercise Number</th><th>Answer</th></tr>
<tr><td colspan="2">Module 1 Application of Part 12 Resource Conservation</td></tr>
<tr><td>Exercise 1-1</td><td>Possible answers include:
• Designated structures
• Tents
• Decks
• Etc.</td></tr>
<tr><td>Exercise 1-2</td><td>Refer to Supplementary Standard SA-1, Table 12 and Division A, Table 3.2.1.1.

<table>
<tr><th>Functional Statement and Objective</th><th>Code Provision</th></tr>
<tr><td>Motion Sensors
12.2.2.1.(2)</td><td>F30-OS3.1
and F10-OS3.7</td></tr>
<tr><td>Air Infiltration
12.3.3.13.(2)</td><td>F54-OH1.2
F55-OH1.2
F131-OR2</td></tr>
<tr><td>Thermal Resistance
12.3.3.3.(1)</td><td>F131-OR2</td></tr>
<tr><td>Required Insulation
12.3.2.1.(2)</td><td>F51-OH1.1
F51-OH1.2
F63-OH1.1
F63-OH1.2
F131-OR2
F63-OS2.3</td></tr>
</table>
</td></tr>
<tr><td>Exercise 1-3</td><td>Yes.
A Part 9 townhouse residential can meet the provisions of Subsection 12.3.3. up to December 31, 2011

Code Ref.: Sentence 12.2.1.1. (1)</td></tr>
<tr><td>Exercise 1-4</td><td>(d) any one of Subsection 12.3.2., 12.3.3., or NRCan EnerGuide

Code Ref.: Sentence 12.2.1.1.(3)</td></tr>
</table>

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<table>
<tr><th>Exercise Number</th><th>Answer</th></tr>
<tr><td>Exercise 1-5</td><td>
<table>
<tr><th>Design Requirements</th><th>Yes</th><th>No</th><th>Code Ref.:</th></tr>
<tr><td>Thermal Design Compliance Option</td><td>✓</td><td></td><td>Clause 12.2.1.1.(3)(b)</td></tr>
<tr><td>NRCan EnerGuide:</td><td>✓</td><td></td><td>Code Ref.: Clause 12.2.1.1.(3)(c)</td></tr>
</table>
</td></tr>
<tr><td>Exercise 1-6</td><td>
<table>
<tr><th>Design Requirements</th><th>Yes</th><th>No</th><th>Code Ref.:</th></tr>
<tr><td>Thermal Insulation Compliance Option</td><td></td><td>✓</td><td>Code Ref..: Article 12.2.1.2.</td></tr>
<tr><td>Thermal Design Compliance Option:</td><td></td><td>✓</td><td>Code Ref.: Article 12.2.1.2.</td></tr>
<tr><td>NRCan EnerGuide</td><td>✓</td><td></td><td>Code Ref.: Sentence 12.2.1.2.(3)</td></tr>
</table>
</td></tr>
<tr><td colspan="2">Module 2A Thermal Insulation Compliance Option</td></tr>
<tr><td>Exercise 2A-1</td><td>(b) 4400

Code Ref.: Table 1.2 “Design Data for Selected Locations in Ontario” in Supplementary Standard SB1. Column 6 lists the number of degree-days below 18℃</td></tr>
<tr><td>Exercise 2A-2</td><td>
<table>
<tr><th>Location</th><th>HDD</th><th>HDD Zone</th></tr>
<tr><td>Belleville</td><td>4100</td><td>1</td></tr>
<tr><td>Ajax</td><td>4000</td><td>1</td></tr>
<tr><td>Timmins</td><td>6200</td><td>2</td></tr>
<tr><td>Dryden</td><td>6000</td><td>2</td></tr>
<tr><td>Thunder Bay</td><td>5650</td><td>2</td></tr>
<tr><td>Aurora</td><td>4300</td><td>1</td></tr>
</table>
Code Ref.: SB-1, Table 1.2 Design Data for Selected Locations in Ontario.
</td></tr>
</table>

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<table>
<tr><th>Exercise Number</th><th>Answer</th></tr>
<tr><td>Exercise 2A-3</td><td>Sault Ste. Marie has 5100 heating degree-days and is in Zone 2.

Exterior walls: 5.10 m^2°C/W
Foundation walls: 3.34 m^2°C/W
Interior walls: N/A
Ceiling below attic: 8.8 m^2°C/W

Code Ref.: Sentence 12.3.2.1.(1) and (4) and Table 12.3.2.1.</td></tr>
<tr><td>Exercise 2A-4</td><td>Ajax in Zone 1
<table>
<tr><th>Assembly</th><th>Min RSI</th></tr>
<tr><td>Concrete Basement floor located at 500 mm below grade</td><td>1.41</td></tr>
<tr><td>Ceiling below attic space:</td><td>7</td></tr>
<tr><td>Exterior Wall:</td><td>3.34</td></tr>
<tr><td>Foundation wall:</td><td>2.11</td></tr>
<tr><td>Ground floor:</td><td>N/A</td></tr>
</table>
Code Ref.: Sentence 12.3.2.1.(4) and Table 12.3.2.1.</td></tr>
<tr><td>Exercise 2A-5</td><td>Ajax is located in Zone 1
<table>
<tr><th>Assembly</th><th>Min RSI</th></tr>
<tr><td>Concrete Basement floor located at 500 mm below grade:</td><td>1.41</td></tr>
<tr><td>Ceiling below attic space:</td><td>7.0</td></tr>
<tr><td>Exterior Wall:</td><td>4 (20% extra)</td></tr>
<tr><td>Foundation wall:</td><td>2.11</td></tr>
<tr><td>Ground floor:</td><td>N/A</td></tr>
</table>
Code Ref.: Sentence 12.3.2.2.(2) and Table 12.3.2.1.</td></tr>
</table>

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Exercise Number	Answer
Exercise 2A-6	(b) 5.23 m^2°C/W Kenora = Zone 2 The RSI value for the total wall assembly for log houses can be reduced from 2.1 m^2°C/W to as low as 1.61 m^2°C/W. If the wall assembly has an RSI value of 1.8. Reduction = Required RSI value– Proposed RSI value Reduction = 2.1 - 1.8 Reduction = 0.3 m^2°C/W in the wall assembly Therefore, the insulation values in Table 12.3.2.1. for exposed roofs must be increased by 0.3. Required RSI for insulation = 4.93 + 0.3 = 5.23 m^2°C/W Code Ref.: Sentence 12.3.2.9.(2)
Exercise 2A-7	(a) 1.76 m^2°C/W The root RSI requirements are set out in Table 12.3.2.1. "Minimum Thermal Resistance of Insulation to be Installed Based on Degree-Day Zones" The house will have a gas-fire forced air heating system. (Columns 2 and 3 are applicable) The slab-on-ground contains heating pipes (Row 7 is applicable) The RSI values listed in Columns 2 and 3 that are associated to Row 7 are the same. Therefore, the degree-days do not need to be computed. A minimum RSI of 1.76 m^2°C/W is applicable. Sentence 12.3.2.4.(7) is not applicable (slab-on-ground is not insulated on the entire underside). Code Ref.: Table 12.3.2.1. and Sentence 12.3.2.4.(7)
Exercise 2A-8	Building is a Part 9 residential building. Minimum annual fuel utilization efficiency for propane furnace is 90%.

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Exercise Number	Answer
Module 2B Thermal Performance – Windows and Doors	
Exercise 2B-1	Thermal performance can be evaluated based on the maximum coefficient of heat transfer and the minimum energy rating. (a) Sliding doors: **Max.** coeff. of heat transfer: 2.0 W/ $m^2 \cdot ℃$ **Min** Energy rating: 17 Code Ref.: Sentence 12.3.2.7.(2) (b) Fixed windows: **Max.** coeff. of heat transfer: 2.0 W/ $m^2 \cdot ℃$ **Min** Energy rating: 27 Code Ref.: Sentence 12.3.2.6.(1) and Subclause 12.3.2.6.(1)(b)(ii) (c) Glazing in operable windows: **Max.** coeff. of heat transfer: 2.0 W/ $m^2 \cdot ℃$ **Min** Energy rating: 17 Code Ref.: Sentence 12.3.2.6.(1) and Subclause 12.3.2.6.(1)(b)(i)
Module 3A Thermal Design Compliance Option	
Exercise 3A-1	• Wall assembly: 3.8 $m^2℃/W$ • Floor assembly: N/A The minimum RSI values for the wall assemblies are applicable only to building elements exposed to unheated areas. The building does not have electric heating: HDD = 4350. Code Ref.: Table 12.3.3.3.
Exercise 3A-2	(a) 2.1 $m^2℃/W$ Code Ref.: Sentence 12.3.3.8.(1) (b) 5.21 $m^2℃/W$ Code Ref.: Sentence 12.3.3.8.(1) and Table 12.3.3.3.

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Exercise Number	Answer
Exercise 3A-3	(a) at least 600 mm below adjacent ground level. Code Ref.: Sentence 12.3.3.9.(2)
Module 3B Thermal Design – Windows and Doors	
Exercise 3B-1	(b) 21.6 m^2 Maximum permitted glazing is limited by both 20% of floor area and 40% of wall area. Floor area = width x depth Floor area = 6 x 18=108 m^2 20% of floor area = 0.2 x 108 = 21.6 m^2 Wall area= 2(depth x height) + 2(width x height) Wall area= 2(18 x 3)+2(6 x 3) = 144 m^2 40% of wall area = 0.4 x 144 = 57.6 m^2 Max. permitted glazing is limited by 20% of floor area = 21.6 m^2 Code Ref.: Sentence 12.3.3.11.(2)
Exercise 3B-2	Yes the proposed glazing does meet the conditions of Sentence 12.3.3.11.(2). Proposed total area of glazing is =total length of windows x height =(2+1+2+1+2+2) x 1m = 10 m^2. Maximum permitted is limited by 20% of floor area = 0.2(60) = 12 m^2. Therefore the proposed glazing are meets the conditions of Sentence 12.3.3.11.(2)
Exercise 3B-3	(b) 45 Area(effective) = Glazing Factor x Area(actual) 18 m^2 = Glazing Factor x 30 m^2 Glazing Facto r= 0.60 Glazing Factor = [Energy Rating (req)]/[Energy Rating (act)] Energy Rating (act) = Energy Rating (req)/(Glazing Factor) Energy Rating(required) = 27/0.60 Energy Rating (required) = 45 Code Ref.: Sentence 12.3.3.11.(3)

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Exercise Number	Answer
Exercise 3B-4	(d) Either design (b) or (c) Code Ref.: Sentences 12.3.3.11.(4) and (5)
Exercise 3B-5	Yes it is permitted. First, determine if the glazing area satisfies Sentence 12.3.3.11.(2) Floor area = width x depth = 10 x 20 = 200 m^2 20% of floor area = 200 m^2 x 0.2 = 40 m^2 Under Sentence 12.3.3.11.(2), the proposed glazing area (50 m^2) is not permitted. However, under Sentence 12.3.3.11.(4), Considered area = 0.5 x 50 m^2 = 25 m^2 Therefore, the proposed glazing area is permitted on the south wall of the new house. Code Ref.: Sentence 12.3.3.11.(2) and (4)
Exercise 3B-6	50% of the area should be considered for each window facing south. The considered area of each window is 1 m^2. And the total considered glazing area is 2 m^2. Code Ref.: Sentence 12.3.3.11.(4)
Exercise 3B-7	The windows need to be shaded in the summer with exterior devices. Code Ref.: Sentence 12.3.3.11.(5)
Exercise 3B-8	Sliding doors have a maximum overall coefficient of heat transfer of 1.6 $W/m^2°C$. Code Ref.: Sentence 12.3.2.8(1)
Exercise 3B-9	Minimum energy rating for operable windows in an exterior wall is 25. Code Ref.: Sentence 12.3.2.8.(2)

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Exercise Number	Answer
Module 3C Air Infiltration	
Exercise 3C-1	Sash crack = Perimeter of all operable portions of a window. =(1.5 + 0.5) x 2 = 4.0 m Air leakage rate = (3.0 Ls)/(4.0 m) = 0.75 L/s per meter of sash crack Maximum air leakage =0.775 L/s per meter of sash crack 0.75 L/s < 0.775 L/s The proposed window meets the requirement of 12.3.3.13.
Exercise 3C-2	Sliding glass door: 2.5 L/s per m^2 of door area Code Ref.: Sentence 12.3.3.13.(2) Operable window: 0.755 L/s per metre of sash crack Code Ref.: Sentence 12.3.3.13.(1) Entrance door: 17 L/s per metre of sash crack. Code Ref.: Sentence 12.3.3.13.(4) Weather stripped and protected by garage: N/A Code Ref.: Sentence 12.3.3.12.(3) Junction: N/A Code Ref.: Sentence 12.3.3.13.(6)
Module 4 Part 9 Residential – NRCan EnerGuide Compliance Option	
Exercise 4-1	Yes. Applications for building permits submitted up to December 31, may achieve a performance level equal to a rating of 80 if evaluated with EnerGuide to meet the minimum energy efficient design requirements of the Code. Note: The building is not required to meet the minimum thermal design nor insulation requirements of Subsection 12.3.3. or 12.3.4. Code Ref.: Clause 12.2.1.1.(3)(c)

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<table>
<tr><th>Exercise Number</th><th>Answer</th></tr>
<tr><td colspan="2">Module 5 Motion Sensors</td></tr>
<tr><td>Exercise 5-1</td><td>
<table>
<tr><th>Area</th><th>Permitted</th><th>Not Permitted</th><th>Code Ref.:</th></tr>
<tr><td>Entrance vestibule:</td><td>✓</td><td></td><td>Sentence 12.2.2.1.(1)</td></tr>
<tr><td>Bedroom:</td><td>✓</td><td></td><td>Sentence 12.2.2.1.(1)</td></tr>
<tr><td>Exit stairwell:</td><td></td><td>✓</td><td>Clause 12.2.2.(1)(a)</td></tr>
</table>
</td></tr>
<tr><td colspan="2">Module 6 Water Efficiency</td></tr>
<tr><td>Exercise 6-1</td><td>(a) Yes. Flow rate of shower head is less than the maximum permitted flow rate

Flow rate = L/min = Total flow/total time = 45L/5min = 9 L/min

Table 7.6.4.1. permits a maximum flow rate of 9.5 L/min for shower heads.

Code Ref.: Sentence 12.4.1.1.(1) and Sentence 7.6.4.1.(1) and Table 7.6.4.1.</td></tr>
<tr><td>Exercise 6-2</td><td>(b) 3.8 Litres

Automatic controls do not affect the flush cycle requirements. However they must be controlled to prevent unnecessary flushing during downtime.

Code Ref.: Sentence 12.4.1.1.(1) and Sentence 7.6.4.2.(3) and Table 7.6.4.2.B.</td></tr>
<tr><td>Exercise 6-3</td><td>(d) 13.25 Litres

Although the fixture was installed post 1996. The actual system is constructed prior to 1996. Therefore, Table 7.6.4.2.A is applicable.

Code Ref.: Sentence 12.4.1.1.(1) and Sentence 7.6.4.2.(2) and Table 7.6.4.2.A.</td></tr>
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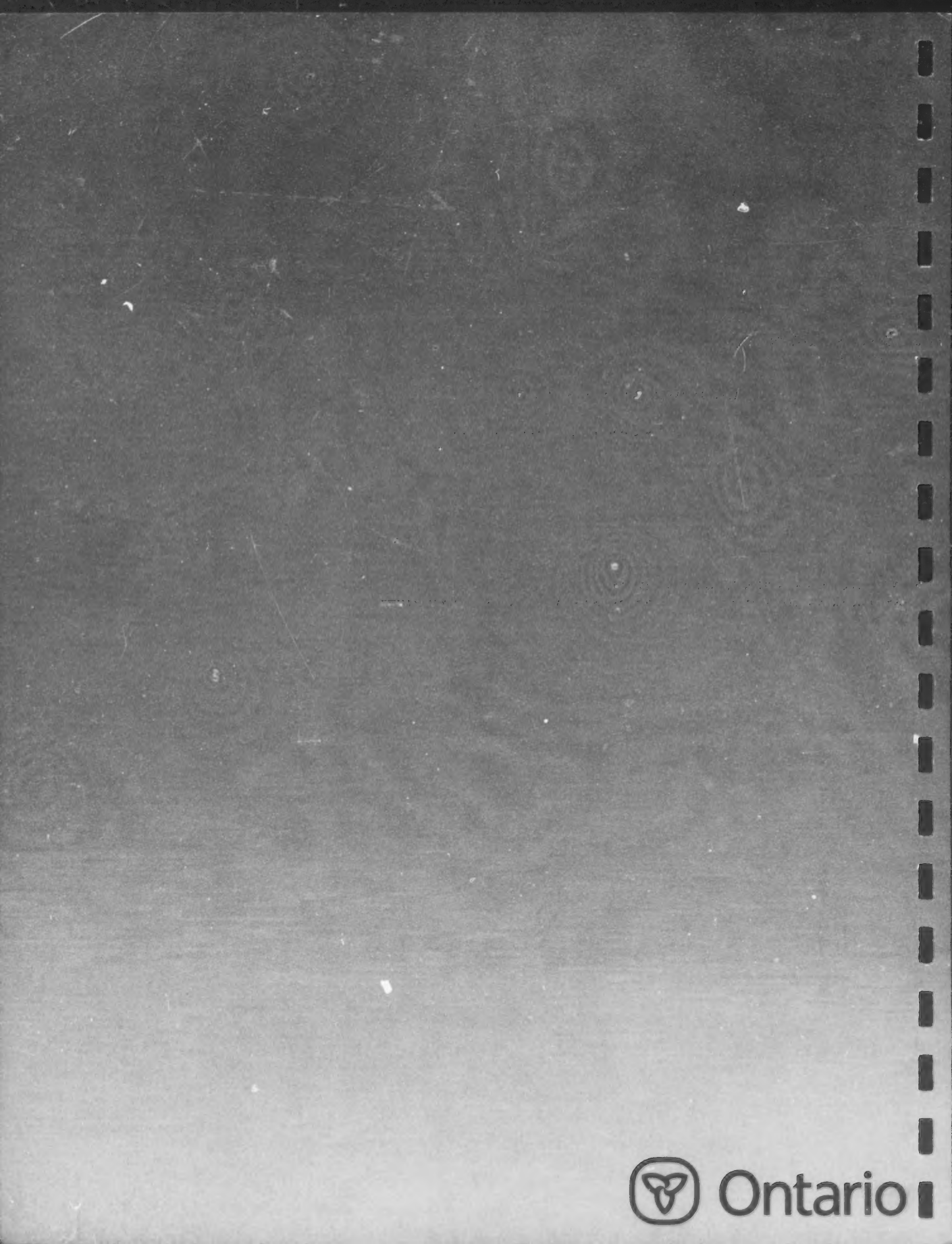
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